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THE MEDICAL CLINICS
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NORTH AMERICA

VOLUME 1 NUMBER 4

CLINIC OF DR. HENRY A. CHRISTIAN

PETER BENT BRIGHAM HOSPITAL, BOSTON

COMPLETE HEART-BLOCK

October 8, 1917.

DR. CHRISTIAN (to a student): Please feel that patient's pulse (P. B. B. H., Med. No. 7345), and as you feel it describe what you make out.

STUDENT: It is very slow.

DR. CHRISTIAN: In the first place, it is a very slow pulse. It has been running about 35 or 36.

STUDENT: It seems to be quite regular.

DR. CHRISTIAN: Yes, it is regular. What are the other characteristics of the pulse? You have given the rate and the rhythm.

STUDENT: There is high tension.

DR. CHRISTIAN: Yes, the tension is high. What about the volume of the pulse?

STUDENT: It is rather increased in volume, I should say.

DR. CHRISTIAN: What other characteristics do you look for in examining a pulse besides what you have already mentioned?

STUDENT: Examine the artery.

DR. CHRISTIAN: What about the artery?

STUDENT: The artery is thickened.

DR. CHRISTIAN: How can you tell whether what you feel is due to the volume and tension of the pulse or thickening of the vessel wall?

STUDENT: You feel the artery after you have stopped the pulse by the finger.

DR. CHRISTIAN: See how that works.

STUDENT: The radial seems thickened.

DR. CHRISTIAN: The pulse is one of good volume and the vessel wall, in addition, is thickened. Look at his brachial arteries to see if you get any information from those in regard to the condition of the artery wall. We are dealing with a patient with a very slow regular pulse, a pulse of good volume, and the artery has a thickened wall.

STUDENT: There is very definite thickening of the wall in the brachial. It is evident there that the pulsation is very marked.

DR. CHRISTIAN: What would you say about that type of pulsation in the brachial? You see there is quite an unusually prominent pulsation in the brachial vessels. What would you say about it? What kind of pulsation is that?

STUDENT: It is not very strong. It comes sharply and then disappears altogether.

DR. CHRISTIAN: Yes, and what else? What is the direction of the pulsation?

STUDENT: Down the artery.

DR. CHRISTIAN: Do you say that because you see it or because you think that is the way it ought to go?

STUDENT: It seems to me I see it first here above and then here below.

DR. CHRISTIAN: Well, that may be true. You may have keen eyesight. The pulse-wave travels very fast and is not an obvious thing. What else?

STUDENT: It is tortuous.

DR. CHRISTIAN: Yes, the artery is tortuous, and what about the pulsation? That is a lateral pulsation. The vessel moves to the side instead of merely heaving, as you would expect. In addition to the lifting pulsation there is a distinctly lateral pulsation—sometimes in one direction, sometimes in the other. Why is that?

STUDENT: It is due to the pressure of the blood in the artery and difficulty of the blood in passing through the arterioles.

DR. CHRISTIAN: That causes high pressure. Why is that vessel tortuous?

STUDENT: It is due to arteriosclerosis.

DR. CHRISTIAN: I mean in a physical sense. Why has it become tortuous?

STUDENT: It has been forced by the pressure—the difficulty of the blood in passing through the arterioles causes back-pressure through the artery.

DR. CHRISTIAN: Does back-pressure usually bend the artery? The blood-pressure is 220 systolic and 60 diastolic, so that it is high. The tortuosity means that the vessel has lengthened. Of course, pressure has a part in that, but perfectly normal pressure may cause the vessel to lengthen. The vessel is relatively fixed at the two ends and if it lengthens it becomes tortuous. The vessel wall dilates or the vessel wall lengthens, or it may both dilate and lengthen. These changes indicate disturbances in the vessel wall. If it dilates irregularly as you run your fingers over it you feel irregularities in the bore of the vessel. If it lengthens, but does not dilate or thicken, you simply see this lateral pulsation, indicating a tortuous artery. The way to recognize the fact that the vessel has lengthened is to watch the pulsation and see if there is a lateral pulsation or to feel the vessel to see if it has become tortuous. This artery looks almost like a worm moving under the skin, particularly in the small branches of the vessel where the curve shifts to one side and then shifts in the other direction.

DR. CHRISTIAN: How does the vessel feel? Is it uniform in size or is it unevenly dilated in different degrees at different places?

STUDENT: It is uniform.

DR. CHRISTIAN: I do not think so. If you run your finger up and down that vessel you feel distinctly narrower and wider places. What do those phenomena teach you about the structure of the vessel wall?

STUDENT: The vessel wall is thickened and hardened.

DR. CHRISTIAN: Why do you say "hardened"?

STUDENT: I can feel that it is hardened—it feels hard under my finger.

DR. CHRISTIAN: Is that due to the thickening—change in the vessel wall—or is it due to the pressure? You can tell that by blotting out the current and seeing what sensation you get without the pulsation.

STUDENT: I should say that there was still some hardening.

DR. CHRISTIAN: I should say that the vessel wall is thick, but it is not a particularly hard vessel. We see calcified vessels that are very firm under your finger, and feel hard like a pencil. As this artery is thickened irregularly you feel irregularities. It is a nodular vessel, but it is not a particularly hardened vessel. It is a sclerotic process and the arteriosclerosis has led to elongation of the vessel, and has led to irregular dilatation of the vessel and the various phenomena that were described. In addition, it is a case of high blood-pressure, so we have, in addition to all the other factors, this increased tension.

DR. CHRISTIAN: Let us look at his neck and see what we can see there.

STUDENT: There is the carotid pulse.

DR. CHRISTIAN: He is a sort of anomalous individual if the carotid is out there. (Discussion in locating the carotid pulse.) Put your fingers on the pulsation and see what you feel.

STUDENT: A very strong pulsation.

DR. CHRISTIAN: I do not feel anything at all there.

STUDENT: I pressed down on it.

DR. CHRISTIAN: I did not tell you to do that. I told you to put your fingers where you saw the pulsation; not to press in deeply. If you feel up here you get a very definite palpable pulse. If you feel down here under the upper edge of the bone there you get a pulsation. That is arterial, but in between where you see those pulsations, if you feel lightly, you get very little pulsation. If you go in deeper, feeling over the artery, you do get a pulsation, but the superficial pulsation is the one you see mostly and is the one you can blot out, but if you make deep pressure you can feel the artery underneath. A pulsation that you can see that way but do not feel much of is always a venous

pulse. It is visible, but not necessarily palpable. What is the rate of that pulsation as contrasted to the impulse at the apex or in the radial artery?

STUDENT: It is very much more rapid.

DR. CHRISTIAN: See if you can make out how many beats take place there compared with each one at the wrist.

STUDENT: There are three to each one in the wrist.

DR. CHRISTIAN: How many ought there to be to each one in the wrist?

STUDENT: One, but it ought not to be visible.

DR. CHRISTIAN: It is visible in a large number of people, and when it is visible how many ought there to be?

STUDENT: One.

DR. CHRISTIAN: What is that due to?

STUDENT: It is due to regurgitation in the veins during auricular systole.

DR. CHRISTIAN: Does not the ventricle produce any change in the veins?

STUDENT: No normal change.

DR. CHRISTIAN: Yes it does. Did not I draw on the board a few days ago a picture of the venous pulse? Did it not have more than one wave to it? How many waves did it have?

STUDENT: Three.

DR. CHRISTIAN: It had three waves—the "A" wave, the "C" wave, and the "V" wave. Ordinarily you cannot see with the cardiac cycle three waves, but if a pulse is going slowly you ought to see two pulsations in the jugular to one pulsation in the radial. One of those is probably the "A" wave and the other one is the "C" wave. Sometimes we can see all three. There is nothing particularly abnormal in seeing two pulsations in the jugular to one pulsation that you feel at the wrist. Very often when we have cardiac cases with decompensation and markedly distended jugular veins with a pretty rapid heart rate there are very numerous beats that you can see in the jugular, but they do not really exceed in number what is the normal relation. It is pretty hard by observation in these cases to say whether there are two or three that you see in the jugular while following the radial pulse, but

certainly there is more than one. Here is a patient with a very slow pulse, and as you watch there I think you can make out that there are distinctly about three visible pulsations in the neck to every one that you can feel, and then as you feel the pulse I think you can see that with the pulse-beat one of those waves is considerably more prominent than the other, and when that takes place all of his neck tissue raises up here, and that is the time of the carotid pulse, corresponding to what you feel, and in the interval between these more prominent pulsations you see a succession of small waves, and there are about two between these bigger ones, so there are really about three pulsations in the neck to one that you feel in the wrist.

DR. CHRISTIAN: Look at his cardiac region now and tell us what you see there in the way of pulsations.

STUDENT: There is a marked apex-beat from here to here. (Indicates on patient.)

DR. CHRISTIAN: Is that synchronous with what you feel at his wrist?

STUDENT: Yes.

DR. CHRISTIAN: When you feel the pulse at the wrist—the pulse-wave coming up—what happens to the apex? Does it go down or up? Is it a forward motion or is it a retraction?

STUDENT: It seems to me I feel the pulsation at the wrist just after the apex goes up.

DR. CHRISTIAN: Perhaps two things happen. Look right here at this particular point.

STUDENT: There seems to be a second little vibration after the first one.

DR. CHRISTIAN: Yes, that is true; there is a localized heave in the apex region when in these two spaces near the apex there is a retraction taking place. The chest seems to come up and then go in almost simultaneously. Then if you will feel in this place you will find that that is apex-beat, while what you described as apex-beat is rather a diffuse systolic retraction. There is a small area which just about the time that you feel the pulse in the wrist distinctly shoves up, and that is the apex-impulse. The adjacent tissue up over the precordium when the apex goes up retracts so

that you get a rather diffuse systolic retraction when at the apex there is a definite apex-impulse and apex-thrust. When the heart is going so slowly you can analyze those things. Of course, in normal cases with a normal rate you cannot analyze those things so well because the heart is beating too fast and the motion in the chest wall is slight. This is a good case in which to study the ordinary phenomena of the normal, just like experimentally slowing down the heart to analyze its parts. That heart is slowed down to 35 or 36 so you can see what is going on. There is very distinctly a thrust or impulse over rather a small apex region, and over all the adjacent precordium there is distinctly a systolic retraction. What causes that difference in those areas?

STUDENT: You mean the difference between the retraction and the thrust?

DR. CHRISTIAN: Yes; the things that we have seen.

STUDENT: The apex being thrust out pulls in the other part of the heart.

DR. CHRISTIAN: What part of the heart is that in the area where the retraction is?

STUDENT: There was retraction over the lower part of the right ventricle and below the heart.

DR. CHRISTIAN: That is not below the heart because the heart is out. The heart is enlarged. It comes out as far as we saw the apex. Put a little diagram of the anterior surface of the heart on the board and mark out what in the lower part is right ventricle and what is left ventricle. (Diagram made.) Probably more than you have put down is left ventricle. The amount of left ventricle that comes to the anterior surface varies a good deal in normal people, and when you come to hearts that have been enlarged usually a larger amount of left ventricle comes forward against the chest wall than takes place in normal hearts. In this patient with an enlarged heart probably in the apex region the left ventricle comes forward to a larger extent. Of course, we cannot tell just how much unless we had the heart in our hands, but a good deal more than normal and a very considerable amount probably is left ventricle. When the heart contracts of course the ventricle contracts and squeezes down, squeezing the blood

out, and that retraction is in large part due to the fact that the right ventricle has contracted, and as it contracts it pulls away from the chest wall. The apex-beat is made by the hardening of the tip of the heart, in this particular case probably in large part left ventricle, at the contraction, and in view of the fact that with the contraction there is a little rotation on the axis of the heart, so the heart as it contracts pushes a little forward and out. The ordinary apex-impulse is due to a combination of the contraction of the ventricle, hardening of the muscle, and with the contraction a slight rotation on the axis of the heart, so that the apex turns forward and outward, and in this particular case you can really see that and feel it unusually well because you can feel the powerfully contracted left ventricle as it turns itself out, as I said, in an area about the size of a five-cent piece, and then you can feel and see the retraction of the right ventricle. The right ventricle is markedly thinner than the left one. The whole thing is the contraction—the powerful muscle of the left ventricle hardening in contraction, then thrusting forward, and then the right ventricle with its thinner wall contracting, and the retraction is due more to the emptying of the right ventricle than to any palpable change in the character of the muscle, and that is exactly what you would expect if you had a thinner and a thicker layer of muscle and those layers of muscle contracting together. You also described a little secondary wave that you can see. It is a retraction which comes down and then goes back, so there is a little double wave that you can distinctly see in the retraction—you see an impulse and see a retraction. There is a rebound, so to speak, of the chest wall—it falls in and then comes out, and when it comes out it does not stop there; there is a rebound, so there is a double wave—the first one more marked, the second one slighter. Look to see if there is anything else.

STUDENT: Up in here there is a pulsation to the left of the sternal margin.

DR. CHRISTIAN: What way does that go in contrast to the other?

STUDENT: It seems to go in this way (indicating a downward direction).

DR. CHRISTIAN: I do not mean so much its transmission. When this is retracting, is that going forward or not?

STUDENT: I think it is. Yes, when this goes down, that goes up.

DR. CHRISTIAN: Yes, that is true. Over the upper part of the chest at the left of the sternum there is a pulsation which is just in the opposite direction to that at the apex. There is a sort of seesaw, when this goes down that comes up, and vice versa. What is that upper retraction due to?

STUDENT: That is from the aorta.

DR. CHRISTIAN: Where is the aorta here?

STUDENT: Along there to the left of the sternum.

DR. CHRISTIAN: That is all right as far as right and left is concerned. How about the anteroposterior direction?

STUDENT: It goes back.

DR. CHRISTIAN: Yes, the aorta is nearer the back than it is the front on the left side. The aorta is way back against the vertebral column, so I guess you do not see any aorta pulsating on the left side. The only point at which the aorta comes near the surface is here in the right chest just above the so-called aortic area. After that the curve goes rapidly posteriorly and to the left. What vessel does lie under the surface here on the left?

STUDENT: The pulmonary artery.

DR. CHRISTIAN: Yes, the pulmonary artery comes out and the aorta curves back in the posterior part of the chest. What else lies in this region?

STUDENT: Vessels.

DR. CHRISTIAN: Yes, vessels and parts of the heart.

STUDENT: Left auricle.

DR. CHRISTIAN: How much of the left auricle?

STUDENT: The left auricle goes back.

DR. CHRISTIAN: Most of the left auricle is behind. Does any come forward?

STUDENT: Just the tip.

DR. CHRISTIAN: Where does that come forward as far as the anterior surface of the chest is concerned or as far as the pulmonary artery is concerned?

STUDENT: Just below the pulmonary artery.

DR. CHRISTIAN: Yes, if you represent the pulmonary artery by my two fingers (demonstration with hand) the left auricular appendage just shows to the left and below it. What do you call that part of the heart just below the pulmonary artery—just below the pulmonary valves? Do you remember the name of that?

STUDENT: I do not remember it.

DR. CHRISTIAN: It is called the conus arteriosus. It comes up in a sort of cone shape, emptying into the pulmonary artery. The pulsation up here is largely due to the pulmonary artery and that part of the right ventricle that opens into the pulmonary artery, the conus; whereas if the auricle comes forward in that region it very rarely pulsates visibly or it is very rarely large enough to give any pulsation to the chest wall that you can feel. There is enough difference in the time relations of contraction of those parts of the heart to give that difference between the retraction in that place and the elevation there. The wave runs up, so to speak, over the heart.

DR. CHRISTIAN: Where does the right auricle come in the outline of the precordium?

STUDENT: The tip is over in here.

DR. CHRISTIAN: Where is most of the right auricle?

STUDENT: It is on the right side behind.

DR. CHRISTIAN: No, most of the right auricle is at the right and extends well back. Practically all of the right border of the heart except a small area is made up of right auricle. Most of the effect of changes in the right auricle as you examine the chest is shown in changes in the right cardiac border. If the right auricle enlarges, the right border goes to the right. If that dilates moderately you do not see any pulsation because the bulk of the right auricle is under the sternum. If markedly enlarged, pulsation is not visible usually, because auricular pulsation is weak.

DR. CHRISTIAN: We have here a slow regular pulse-rate and you can see a jugular pulse that is going apparently faster than the arterial pulse; what would you say was a possible mechanism working in the heart to produce those results?

STUDENT: Partial block.

DR. CHRISTIAN: What do you mean by partial block?

STUDENT: The auricle is beating faster than the ventricle and all impulses from the sino-auricular node are not causing ventricular contractions.

DR. CHRISTIAN: What sort of a relation do you have to have between the auricle and the ventricle under those circumstances to give you a regular pulse?

STUDENT: Every contraction from the auricle would be transmitted down to the ventricle

DR. CHRISTIAN: That is the normal relation. I mean what sort of a partial block would you have that would give you a regular ventricular pulse?

STUDENT: Every second beat of the auricle would not be transmitted.

DR. CHRISTIAN: Yes, you would have to have a block in which every second beat or second and third beat, etc., of the auricle was not responded to by the ventricle and then you would have a regular rate. Ordinarily with partial block we may have that, or we may have two beats and then the third one dropped out, giving a regular irregularity, or you might have three or four beats and then one be dropped out, which would still give a regular irregularity, but if you have an occasional beat dropped out you would get an irregular type of irregularity.

DR. CHRISTIAN: Why is the pulse as slow as that in partial block?

STUDENT: The ventricles contract just about half or less than the normal.

DR. CHRISTIAN: Yes, the normal rate you see is about 80, and if every other beat is dropped out you have a pulse at about that rate—35 to 40. Suppose you had a still slower pulse, would you still think it was a partial block?

STUDENT: It might be, or it might be complete.

DR. CHRISTIAN: Yes; the slower the rate, the greater the probability of the block being complete. Partial blocks are much more apt to give more rapid rates than 40. One reason is that most of those cases have a certain amount of cardiac decompensa-

tion, and the heart, if it were not for the block, would be going faster than the normal, so that though many beats dropped out, the reduction in the rate would not be great. You cannot tell from such observation as we have made whether there is partial block with just every other beat dropped out or one with two or three auricular contractions and then a normal ventricular contraction, or whether it is a complete block. All you can say is that we have a patient with arteriosclerosis, with an enlarged heart, having a very slow regular rate, but apparently in the neck you can see more pulsations than should go to the number of ventricular pulsations that you can see over the heart or at the radial or brachial artery, and that all suggests heart-block. If you take a pulse tracing with a tracing of the vein you get graphic evidence, or if you take an electrocardiogram you get graphic evidence of what is going on. There are the electrocardiograms (Fig. 82) taken from this patient. What is the first thing that strikes your eye in looking at any one of the leads as a departure from the normal?

STUDENT: The "R" wave is down in Leads 2 and 3.

DR. CHRISTIAN: That is the ventricular complex. The "R" wave is down in Leads 2 and 3 and up in Lead 1. That marked difference indicates a muscle preponderance on one side or the other, that is hypertrophy; and in this particular form in the first lead the ventricular complex mainly up and in the third down, left-sided hypertrophy which fits in with what we talked about—enlargement of the heart, a forcible apex-beat, etc. As far as the ventricular complex is concerned there is left-sided hypertrophy. Then they are quite far apart, indicating a slow rate, and they come regularly. What comes in between those up-and-down strokes? Taking that lead (Lead 1), what sort of waves appear in between?

STUDENT: Two waves.

DR. CHRISTIAN: There are two waves very much alike in that particular place. The thing to do when you are analyzing any one of these curves is when you find any particular kind of wave that catches your eye to run your eye along the record to see when it recurs, if it is just the same in form, and how many there

are, and what relation they have to some other kind of a wave that you pick out in the same way, following along with your eye. In

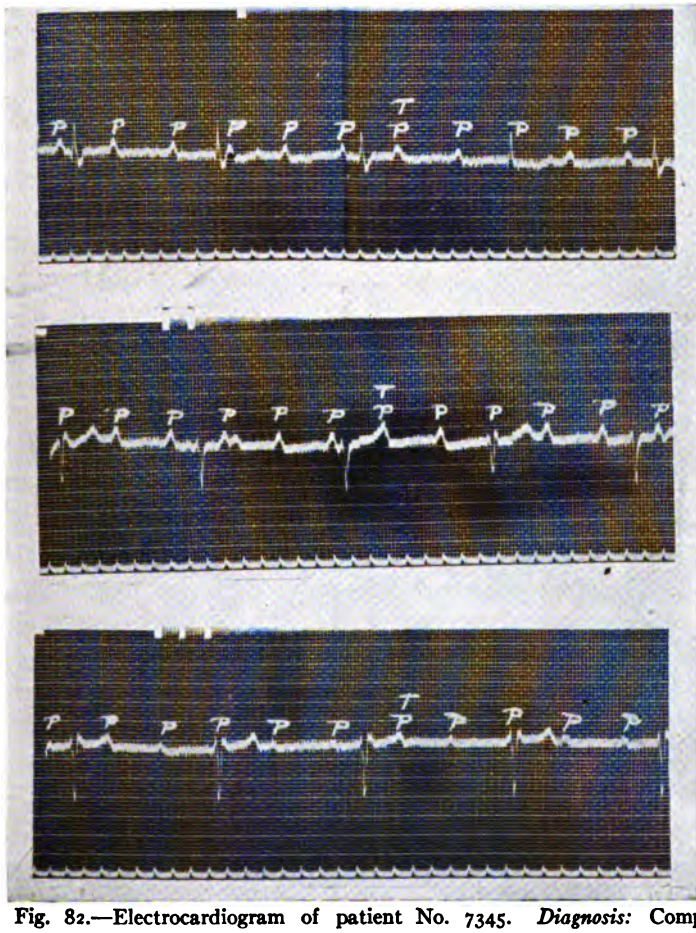

Fig. 82.—Electrocardiogram of patient No. 7345. *Diagnosis:* Complete heart-block; left ventricular hypertrophy. Auricular rate 132 per minute; ventricular rate 37. *P* indicates contractions of the auricle and the larger unmarked waves indicate ventricular contractions. Note that both auricles and ventricles are contracting regularly, but the contractions of the auricles bear no fixed relation to those of the ventricles.

analyzing these curves look to see whether a particular kind of wave that you pick out occurs regularly and evenly spaced. You can measure the distance between the beginning of different

waves and when the waves come at regular intervals you conclude they are the same things if they have the same form, and that each wave is caused in the same way and represents a definite part of the cardiac cycle repeated at a regular rate. Studying the curves this way you find a regular sequence of two types of waves ("P" waves and "R" waves), but with no constant relation to each other.

That is a case not of partial block, but of complete dissociation. The auricles are beating regularly at one rate and the ventricles are beating regularly at a different rate. One is approximately twice as fast as the other, but there is no constant relation between "P" and "R" waves. Dr. Drinker in making the curves has counted out the auricles going at a rate of 132 per minute, and the ventricles going at a rate of 37 when he took the tracing. It is a case of complete heart-block in a patient with a very considerable degree of arteriosclerosis and a hypertrophied heart without any valve lesion at all. The heart sounds are normal. There is a little soft systolic murmur that is very common in cases of heart hypertrophy when there is no real valve lesion. Heart-block occurs in people that have simple arteriosclerosis; it occurs in syphilitic cases. The Wassermann reaction has not been done on him yet; that will be reported on later.

We have not a very satisfactory history of the patient because he is an Italian with a rather limited knowledge of English. The patient says that previous to a year ago he had no symptoms at all from his heart or lungs. A year ago he fell two stories while working and broke his left ankle. Also he injured his arms and his hip. He injured himself pretty seriously, because he was taken to the Boston City Hospital and remained there two months with his leg in a plaster cast. Probably he fractured his leg. The patient states that in the City Hospital he began to notice dizziness and blurring of vision. This came on periodically. He does not think that when at the City Hospital he had anything the matter with him except as the result of the fall. At the end of two months he left the hospital against advice. He stayed about the house at home for about a month. While at the hospital before he went home he had noticed dizziness and he

at several times had fallen over, although he never hurt himself in any of these falls. He says for the past eight months these attacks of dizziness came on once or twice every day. Quite often he had had to lean up against a building or catch hold of something to keep him from falling down. He had never vomited in any of these attacks. Several times while out on the street he has been mistaken for being drunk, and on one occasion he was actually arrested. (It is not very long since we had another patient with pathologic dizziness who was arrested for drunkenness. That shows the activity of our police and sometimes their failure to discriminate.) He has been unable to do any work and scarcely ever goes out of the house for any length of time without having these attacks of dizziness come on. Naturally, he is afraid to go out. During these attacks his eyes begin to roll, things go round in circles, and very often during these attacks he has palpitation of the heart. There is no history of any loss of consciousness. There have been no attacks of nocturnal dyspnea, no cough, no swelling of the feet or abdomen. He says that if he talks for any length of time he gets very dizzy and very short of breath.

His history as far as we know, but we are not absolutely certain, dates back for about a year and consists in recurring attacks of dizziness and enough of that to keep him from work and pretty well confined to the house, and yet he has never had any severe dyspnea or any edema indicating a decompensated heart, nor has he had any attacks of actual loss of consciousness.

It is a little difficult to explain just why he should have dizziness in recurring attacks. It may be that his heart-rate varies from time to time, and if it slows beyond a certain point, nutritional disturbances in the brain result from the slowed circulation and bring on the dizziness. Since we have observed him in the hospital on only a few days have there been any very marked variations in his pulse-rate. Some of these cases of heart-block have periods in which the heart slows down very much in rate; it drops down to 10, 12, 14, or something like that. Those patients then become dizzy or lose consciousness. He may have had something of the same nature, but not a drop in rate slow

enough or of long enough duration to produce unconsciousness. When they lose consciousness we speak of that as Stokes-Adams disease or Stokes-Adams syndrome, named for two Irish physicians who a good many years ago described these cases of abnormal slowing of the pulse accompanied by attacks of unconsciousness. It is not proper to call the condition Stokes-Adams disease unless there are definite attacks of loss of consciousness. Recurring attacks of dizziness in a patient with a slow pulse are not to be called Stokes-Adams syndrome. Consequently we simply speak of this as a case of complete heart-block—complete dissociation between the auricles and the ventricles, and not a case of Stokes-Adams disease.

We see dizziness also in a number of our patients who have a normal heart-rate, but who have a high blood-pressure or have arteriosclerosis, or both, so that the attacks of dizziness in this man may be associated only in part with the slow heart-rate, and in part we can associate the dizziness with the high blood-pressure and the arteriosclerosis which he has. Arteriosclerosis causes attacks of dizziness not because the peripheral vessels are sclerosed, but because the cerebral vessels are sclerosed. We take it for granted that if the peripheral vessels are sclerosed there is probably sclerosis of the cerebral vessels. As this man has marked peripheral sclerosis we think very likely his cerebral vessels are sclerosed also. That and the high blood-pressure may produce his disturbance. The cases with sclerosis and high blood-pressure often do have temporary attacks of dizziness. The sclerosis does not change, that is a slowly progressing process. It cannot change from hour to hour or day to day. The blood-pressure, as a rule, as far as we have observed it does not vary suddenly in these cases, so we have to assume that the dizziness is due to some other circulatory disturbance than change in blood-pressure or change in heart-rate or change in the vessel wall, and various theories have been advanced as to just what takes place. Most of them ascribe the cause to some form of transitory anemia or transitory edema of the brain in some way related to the poor circulation in a case with thickened vessels and hypertension. As I have said, we see a great many cases of high tension and

sclerosis with dizziness. Complete heart-block is a much more unusual condition, and those cases sometimes have these attacks of dizziness, but just whether the attacks of dizziness are due to slow rate, hypertension, or arteriosclerosis we cannot say. Very likely all three play a part. This patient also has a considerable amount of abdominal discomfort. He seems to complain a good deal of his abdomen. Possibly he also has arteriosclerosis in his abdominal vessels and has disturbance from that.

October 15, 1917: The patient that I showed you at the last clinic, the Italian with the heart-block (P. B. B. H., Med. No. 7345), has made no change since you saw him. He is still in heart-block, but we have this added feature in his case that we did not have at that time, we know that he has a double positive Wassermann reaction, so that antiluetic treatment will be instituted and we will watch the effect as indicating whether or not he has some luetic lesion causing the block, and in that case one that will clear up under antiluetic treatment. When I showed the patient, his blood had just been sent down to the laboratory for the Wassermann reaction. It was done the following day and was confirmed by repetition, both times being double plus.

November 6, 1917: You may be interested to hear of the patient that I showed at an earlier clinic, the case (P. B. B. H., Med. No. 7345) of complete heart-block. That patient with the complete heart-block and positive Wassermann reaction is still in the ward. He is having antisyphilitic treatment and it is not doing him any good, that is, the heart-block continues, and his signs of heart-block and his symptoms are probably more marked than when I showed him to you. The night before last his pulse went down to 18 and during that time he complained, as he did before, of abdominal pain and of dizziness, and with this slowing of the pulse he got an attack which I think probably is best explained as hysteric manifestations. He writhed around in bed, groaned, mumbled, etc., and I think part of that is hysteria probably due to the fear of impending death or something of that sort with slowing of the heart-rate. Notwithstanding the positive

[illegible] reaction the treatment has not produced any change and the block has continued, and with the complete block at times his interventricular rate slows down. The slowest that has been counted so far is 15 per minute. He has no signs of cardiac decompensation.

PARTIAL HEART-BLOCK WITH STOKES-ADAMS SYNDROME. DIGITALIS HEART-BLOCK IN AURICULAR FIBRILLATION

PARTIAL HEART-BLOCK

October 16, 1917.

DR. CHRISTIAN (to a student): Please take this man's pulse (P. B. B. H., Med. No. 7374) and see what you make out.

STUDENT: It is an irregular pulse, rapid and weak, and the beats vary in character.

DR. CHRISTIAN: How fast is it?

STUDENT: 108.

DR. CHRISTIAN: It has been running in the ward, as a rule, more slowly than that. Most of the counts have been about 80. They run from 95 as a high level down to 60 as a low level. Just now I should think it is not very much faster than about 85 as I feel it. What is the type of irregularity? What did you notice?

STUDENT: It is irregular in time and there seems to be a skipped beat.

DR. CHRISTIAN: What do you mean by that—skipping like someone skipping rope?

STUDENT: It goes rapidly for eight to ten beats and then it slows. I think it goes slowly for three or four beats and then returns to the rate it was going at before. There is not any great change between those periods.

DR. CHRISTIAN: There are three or four beats at a certain speed and then three or four at a slower rate and then restoration of the previous rate. We do not call that skipping beats. What sort of an irregularity is that—periodic slowing and increasing in speed, three or four slower and then three or four faster, and then three or four slower again—what would you say that was?

STUDENT: A sinus arhythmia.

DR. CHRISTIAN: Yes, that is a sinus arhythmia. Keep feeling the pulse and tell us if you get any other form of irregularity. What did you get then?

STUDENT: A dropped beat.

DR. CHRISTIAN: What do you mean by that? Describe to the class what you felt.

STUDENT: There is a total pause between the two. The time period between those two beats is greater than the time period between two others.

DR. CHRISTIAN: Here is a heart going at a certain rate, then there is a pause, and then the heart goes on at the same rate. Did you form any idea as to how much longer a long pause was than the preceding one? That happens very occasionally.

STUDENT: Roughly, it seems to be about double.

DR. CHRISTIAN: Yes, that is about the right expression. As you feel the pulse occasionally there is a period between the beats of practically double length and then the normal rate immediately returns. The pulse is going at a normal rhythm and normal rate, and then every once in a while a beat drops out completely and nothing takes its place, but there is no other disturbance in the rhythm. This dropping out does not happen very often.

DR. CHRISTIAN (to student): Just examine the heart quickly as to size, murmurs, etc.

DR. CHRISTIAN: I will give you the patient's history while Mr. ——— is going over the heart for other abnormalities. He is forty-seven years of age and is a painter by occupation. He was admitted to the hospital on the 10th of October. His family history is entirely negative. He has been married fifteen years. His wife is living and well. There have been no children, no pregnancies, and no miscarriages. He formerly drank one or two whiskies daily for several years back, but for the past three or four months he has not used any alcohol. He chews and smokes, using 70 cents' worth of tobacco in a week. He drinks no tea or coffee. Recently he has been taking some sort of medicine given him by his doctor, but he does not know what it is. He has been a painter for thirty years. He has always taken good care to clean his hands well and has had no symptoms of lead-poisoning. He

works seven to eight hours daily and most of his work is indoors. He had to stop work on September 25th on account of the present illness. He has always lived in Boston. He had what he was told was typhoid pneumonia at the age of fourteen years. He was not seriously ill and made a good recovery without complications. He does not remember any of the children's diseases, but says that during the past eight or ten years he has had several slight sore throats lasting about a day or two, but none of these were very severe. He was asked specifically about the various common infectious diseases, but he apparently has had none of them. There is nothing in his past history of importance in regard to his head or throat. As to his cardiorespiratory history, five or six years ago he had rather sharp pains over his heart which lasted several weeks. These pains disappeared without treatment. They were sharp and stabbing, coming suddenly and disappearing suddenly. He has also noticed for two or three years that in going up steps or walking very fast or if he makes any severe exertion he becomes somewhat dyspneic and has palpitation. There is no other history of pain in the chest and no dyspnea beyond what I have given. There has been no cough or hemoptysis. He thinks that occasionally he has had night-sweats. His gastrointestinal history is entirely negative in the past. His stool has been dark for the past two weeks, but he thinks that this is due to medicine that the doctor has given him. Forty years ago he had a Neisser infection which lasted for three weeks. He was treated and recovered without complications. There has been no other urinary or genital disturbance. His present illness is as follows: On the 22d of September, while standing on the street talking to a man, the patient says he had a sudden "flash." During this time everything became dark before his eyes and things disappeared. This attack only lasted, just as he expresses it, as a flash of darkness and then cleared up. The whole thing lasted probably about two seconds, that being his idea of the time. He thought nothing about it, but next morning while walking along he had another "flash." "Flash" means apparently this temporary darkness. Along with this dark sensation he had what he called a "gone feeling" around his heart. He came very

near falling, but the whole thing was over in a short time and he did not fall. Two days later he stooped over to take up an object and on standing up again he fell over backward. He says things looked black and then he lost consciousness and fell to the floor. He states that he struck his head on a bench when he fell and that he remained on the floor for about one-half hour, but was not unconscious during all this time. (I think the period of unconsciousness was a short one and he was either afraid to get up or felt badly enough not to attempt it, or possibly he was totally unable to get up.) After about one-half hour someone helped him up and in a short time he felt all right again. During these attacks all the blood in his body seems to rush to his head, he is numb all over, and has a gone feeling over his heart. He says that some of these attacks last from five to ten seconds and following the attacks he feels bilious for awhile. These attacks have gradually increased in frequency until now after exercise or walking fast he has three or four attacks in five to ten minutes. He has never lost consciousness except in the one instance mentioned above. That is all of recent development, beginning September 22d. What do you make out about the heart; first, as regards size?

STUDENT: I do not get the left border on percussion, but the heart is very much enlarged.

DR. CHRISTIAN: The heart is enlarged, but it is not enlarged quite as much as you would make it to be. I have my finger on the apex. It is a few centimeters outside the nipple line. The exact distance for our present purpose does not make any great difference. Here is a man with a heart that is enlarged so that the apex is well outside the left nipple line. What did you hear on listening?

STUDENT: The sounds are muffled and distant. I heard a systolic murmur and a murmur which follows the second sound.

DR. CHRISTIAN: In the first place, the sounds are not very loud. In the second place, the first and second sounds are rather definitely similar in character. In the third place, there is a distinct blowing, not very loud systolic murmur heard at the apex. The same systolic murmur is heard at the base. It is probably

a little louder in the aortic area than in the pulmonic area. In the pulmonic area the second sound is immediately followed by a very short diastolic murmur. The same diastolic murmur is heard faintly at about the nipple, slightly inside the apex. There are no palpable thrills. As far as the heart goes, it is simply a heart showing enlargement with a slight blowing systolic murmur which I think only indicates a relative mitral insufficiency. The diastolic murmur is possibly associated with slight regurgitation at the aortic or pulmonic area or possibly suggests a slight mitral stenosis. The intensity of the murmur and the general character would make you think the patient essentially has no valvular lesion in the heart except simply a slight relative insufficiency of the mitral ring; in other words, it is an enlarged heart and is essentially a condition of slight chronic myocarditis.

QUESTION BY A STUDENT: Does the fact that the sounds are somewhat similar in character have any significance?

DR. CHRISTIAN: Yes, that means a disturbance in the heart muscle, the sounds approaching each other in quality. Ordinarily there is a distinct difference between the first and second sounds whether you listen at the apex or at the base. Sounds approaching each other in quality may change in two directions; either the first sound, which is normally a muffled one, can become sharp like the normal second sound, or the second sound, which is ordinarily a sharp one, may become a muffled sound and similar to the first sound. In this particular case both sounds are muffled and are similar to the ordinary type of first sound when you listen at the apex and that goes usually with myocardial weakness. The other change—the change in the other direction —suggests mitral stenosis. Did you make out anything abnormal in the neck?

STUDENT: There is a marked pulsation on the right side.

DR. CHRISTIAN: There is a very definite venous pulsation in the neck. I would not call it very marked. It is very easily seen, but you have not seen any really marked one where the veins stand out, and you can see with great intensity all the little pulsations. This is not anything more than a great many normal people have. You can see perfectly well the venous pulsation in

the neck. There is no trouble about seeing it, but what I am criticizing is that you ought not to call that marked. It is not marked. You apparently have not seen a case of marked pulsation. I will show you some before we go very far and you can see the difference. Sometimes the veins stand out like cords in the neck and you see a pulsation running up and down with every cardiac impulse, so that at the first glance at the patient you notice the striking pulsation. This is an easily visible pulsation, but it is not a very marked pulsation.

I may say that while listening to the heart I happened to catch one of those irregularities such as happened before when I was feeling the pulse, and during that interval nothing was heard at all. I mean there was no beat, no first sound, no second sound, no murmur. There was no interruption in the character of the beats or the character of the murmurs just before or after that beat was missed.

STUDENT: I find nothing abnormal in the neck unless it is that sometimes the beat seems to be followed by two sorts of waves.

DR. CHRISTIAN: Yes, sometimes you see a double wave; a more prominent one and then a less prominent one. Is that abnormal or normal?

STUDENT: I should think that was normal.

DR. CHRISTIAN: Yes, that is normal. As I have said before, there are three waves ordinarily in the venous pulse as traced by graphic methods, but you do not, as a rule, see more than two. To see two waves, one a little larger and one smaller, is a normal thing, and you are perfectly right in saying that is a normal looking venous pulse in this patient. If you happened to look when those beats dropped out you would see something different. That happens only occasionally, and ordinarily as you watch that it is a perfectly normal jugular pulse in the neck. It is quite easily seen, but that does not constitute any great abnormality. That is essentially all that is to be made out on physical examination of the patient. Everything else is normal.

Now we will take up the analysis of that irregularity and see what we find. Here is a tracing (Fig. 83) taken when the patient

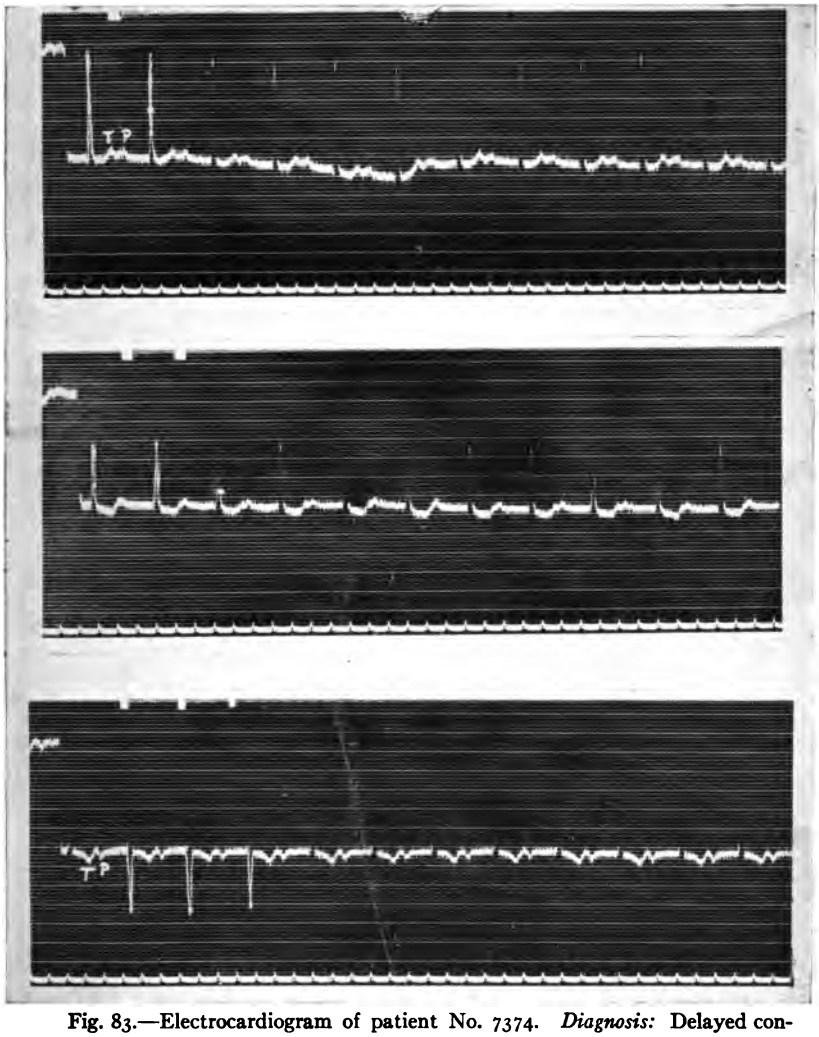

Fig. 83.—Electrocardiogram of patient No. 7374. *Diagnosis:* Delayed conduction time, *P–R* intervals 0.36 second; left ventricular hypertrophy. *T* indicates wave marking the end of the ventricular activity. *P* indicates wave corresponding to the contraction of the auricle. The larger unmarked waves represent the wave of the early activity of the ventricular contraction. Note the increased interval between the contraction of the auricle (*P*) and the beginning of the activity of the ventricle.

was quietly lying in bed. See if you find any irregularity in that? These very fine lines represent the ventricular contractions. It

happens that the electrocardiogram was taken with a very fine string and the line of the ordinary wave of the ventricular complex is not very marked. The string moves up and down very quickly, making a very fine line. As far as that goes, the ventricle is beating perfectly regularly in this lead. That is the "T" wave completing the ventricular complex and those are the "P" waves. What would you say about the "P" waves in relation to the ventricular complex?

STUDENT: They are more removed than normal from the ventricular beat.

DR. CHRISTIAN: Yes, they are more removed. The time between "P" waves and "R" waves, in other words, conduction time, is eight-twenty-fifths to nine-twenty-fifths of a second. The normal conduction time is one-fifth of a second or a little less. We are dealing with a patient whose heart is regular, but who has delayed conduction time, and that delay is practically twice the normal. It takes twice as long for the impulse to go from the auricle to the ventricle in this particular patient as is normal, and over long periods of time that happens, and nothing else. You remember he says that following exercise he has what he described as these "flashes," coming on suddenly, then disappearing, and he has the feeling as if his heart stopped in that period, so we gave him a little moderate exercise, having him stand up and lie down, and in an electrocardiogram taken immediately after that exercise you notice in the first place a regular rate over most of it with delayed conduction time, and at one point the period between the ventricular complexes becomes practically twice as long as the regular rate. When that happens there are two "P" waves and between those two "P" waves there is no ventricular complex; in other words, strictly speaking a dropped beat or a blocked beat brought on by exercise—delayed conduction without exercise, with exercise some blocked beats. We have repeated that on other occasions. On the 13th of October before exercise there was occasionally a dropped beat, and after exercise rather more frequently these dropped beats.

QUESTION BY STUDENT: How can you tell that that is a "P" wave and not a "T" wave?

DR. CHRISTIAN: From its relation to the "R" wave, the relation in different leads always being the same. When Mr. ——— passes those others around you will see that the "T" waves are all inverted in the next curve and unlike the "P" waves. If you look closely in the other lead you will see that the "P" wave is not exactly like the "T" wave. The "P" waves are the same as repeated and the "T" waves are the same, but they are different from each other.

That is the other picture of heart-block. I showed you before (P. B. B. H., Med. 7345) the patient with heart-block where there is complete dissociation; the auricles and the ventricles beating independently in a patient with marked arteriosclerosis and a large heart, and, as subsequently added, a double positive Wassermann reaction, and his symptom was frequent dizziness, no loss of consciousness. Here is a patient who has once lost consciousness and immediately following exercise has a delayed conduction changed into a partial heart-block and has sensations at that time depending upon how many beats drop out or how slow his heart-rate becomes. Probably the time he lost consciousness his rate slowed down to one-half of the normal or possibly less. Recently his heart has been going at about a normal rate with an occasional dropped beat. That, so far as he has had attacks of loss of consciousness, etc., is a case of Stokes-Adams disease. It is not a well-marked case such as we may possibly see later on. That condition was recognized in the ward before electrocardiograms were taken on the basis of the man's description of his attacks and feeling these occasional beats that simply disappeared—dropped out. We were not at all surprised when we got an electrocardiogram to find the man had a disturbance in conduction time. In fact, notes were made in the history before any electrocardiograms were taken that it was probably a case of heart-block with Stokes-Adams disease. I am emphasizing that simply to bring out the point that it is possible in these arhythmias to form a pretty good idea of what is going on in many of the cases, and by that I mean the mechanism of the irregularity, without having elaborate means, either polygraphic or electrocardiographic, of recording the irregularity. The

Wassermann reaction is negative in this patient. Syphilis is not an etiologic factor. There is not a very marked change in the blood-vessels. Possibly there is a little arteriosclerosis. He is a painter, but so far as we know lead has never produced any serious damage in him. He has never had lead-colic, never had a dropped wrist, or any of the other symptoms of lead-poisoning. His heart is enlarged and the sounds indicate a myocarditis. As far as we can go he is a patient with a myocardial disturbance. In various places in the heart there is some sort of lesion, and among other places there is a lesion that interferes with his conduction time and slows it to one double the normal length, and very often, particularly after exercise, the ventricular beats drop out altogether.

QUESTION BY A STUDENT: Are you more apt to have Stokes-Adams syndrome with partial block than with complete?

DR. CHRISTIAN: It does not follow any definite rule. The syndrome comes when the heart occasionally slows down enough to give poor circulation to the brain. If you get anemia you get loss of consciousness or irritation, and if irritation, you get convulsive seizures, and that is all you can say. That might come in complete block or it might come in partial block. Probably more often it occurs with complete dissociation than with partial block. Stokes-Adams syndrome is much more infrequent than heart-block, *i. e.*, we see many cases of heart-block of various types which do not have the Stokes-Adams syndrome.

November 6, 1917.

DR. CHRISTIAN: The patient (P. B. B. H., Med. No. 7374), who had pretty definite Stokes-Adams syndrome of a mild character with delayed conduction time and increased block brought on by exercise, we put on thyroid extract following a suggestion which came from Dr. Blackford of the Mayo Clinic,[1] that as thyroid had an influence in increasing the heart rate, it might have an effect on the patient's block. As a result of thyroid medication in our patient the auricular and ventricular rate increased and conduction time decreased. He left the hospital

[1] Blackford, J. M., and Willius, F. A., Amer. Jour. Med. Sci., 1917, cliv, 585.

some ten days ago, and before he left we were no longer able to produce any of those periods of heart-block. You remember we brought on definite block when he first came in by having him exercise a little bit. Just before he left we ran him up and down stairs trying to produce a block, but could get none (Fig. 84, electrocardiogram of October 23d after exercise). He could go up and down stairs perfectly well, and do such things that he had been unable to do since these attacks developed. He went out to continue taking the thyroid until he got some signs of thyroid intoxication. What will be the permanent result on that patient I have no idea, but as far as seen from our observation thyroid increased his heart-rate, and in doing that had not simply an effect on the auricle and ventricle, but there was an increased rate of conduction, so that the slowed conduction time, whereas it had not come to normal when he left, had been reduced to almost a normal conduction. As I remember it, it was almost two-fifths of a second when he came in and it was somewhat over one-fifth of a second when he left. The symptoms of block disappeared with that change in his conduction time after using thyroid extract.

Subsequent Note.—After leaving the hospital the patient took thyroid extract for one week, then discontinued it. After a few days his symptoms returned and increased in severity. He came back to the hospital and was found to have complete heart-block. Thyroid extract was begun again. The first few days in the hospital the patient was very uncomfortable, had periods of unconsciousness, and a slowed heart-rate. At times there would be intervals as long as fifteen seconds between ventricular beats. Gradually the block decreased, and on December 8th electrocardiograms showed no blocked beats, his pulse was regular, but the conduction time was delayed as it was on his first admission.

DIGITALIS HEART-BLOCK IN AURICULAR FIBRILLATION

DR. CHRISTIAN (to a student): I wish you would come down and feel this patient's pulse (P. B. B. H., Med. No. 7313).

This patient is thirty-six years of age. Her family history is negative. She was born in Russia and has lived in Boston for

fifteen years. She had measles as a child. She has had tonsillitis five or six times; the first time fourteen years ago, the last time one

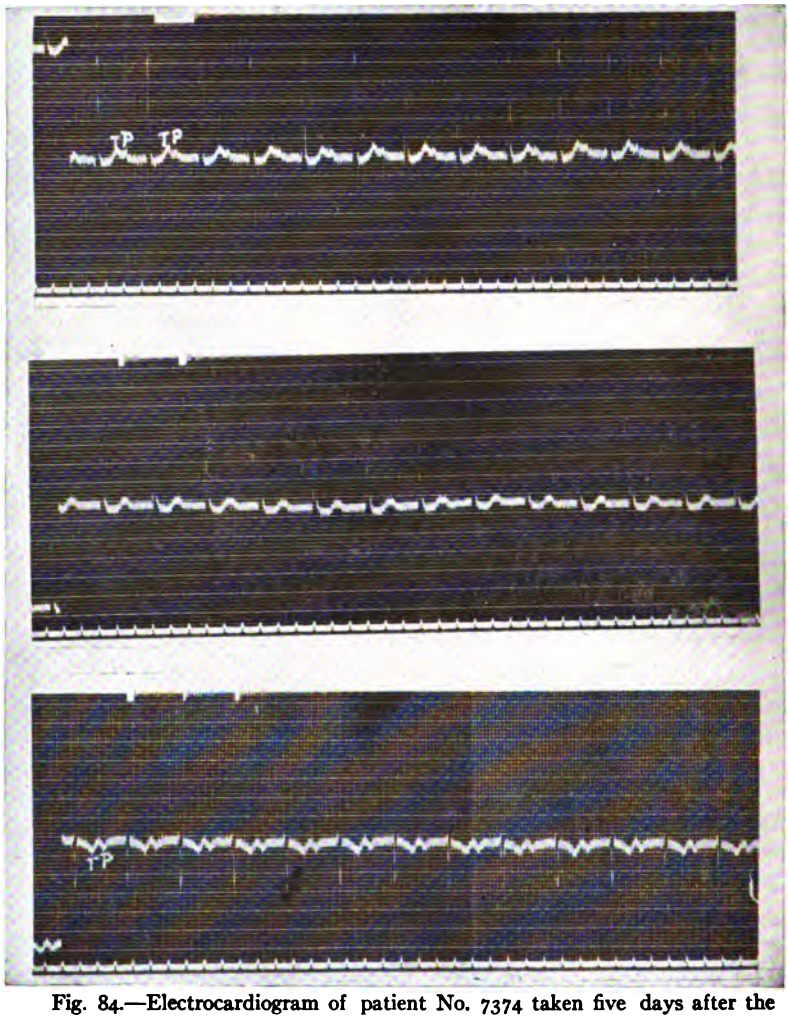

Fig. 84.—Electrocardiogram of patient No. 7374 taken five days after the electrocardiogram shown in Fig. 83. *P–R* interval has shortened and is now 0.28 second following thyroid extract, 0.13 gram three times a day.

week ago. She had an attack of rheumatic fever six years ago. She was ill in bed at that time for three weeks. There is no history of any of the other acute infectious diseases. For the last six

months the patient has noticed black spots before her eyes, but no failing vision, no inflammation of the eyes, and no pain in the eyes. She has had frequent attacks of tonsillitis which I have already referred to. Her gastro-intestinal history is entirely negative. Her genito-urinary history is entirely negative. She has lost weight. A year ago she thinks she weighed 170 pounds. Now she weighs 135 pounds. Her present illness seems to date back quite a period—to ten years ago following a very severe attack of tonsillitis. On recovering from this she fainted on several occasions. A local physician who was called in told her that she had heart trouble. That was ten years ago, and at that time she was very edematous and had sharp, stabbing pains over the precordium. She was kept in bed for eight months. She then got up and felt well until two years ago, when she fainted while washing clothes. At this time she had no palpitation, but did have slight edema. Followng this attack she did her own work about the house, getting along fairly well until three months ago. At that time she began to cough and about this time she became short of breath. Palpitation became very troublesome and her legs became very much swollen when she was up and about on them. During the past four weeks she has been in bed most of the time. Five days ago she became very dyspneic. On several occasions she has had a sharp pain in the epigastrium, radiating through to the back. These pains come on suddenly at any time and usually last about one hour.

What do you make out in her pulse?

STUDENT: She has a very irregular pulse. There seemed to be three or four strong beats, then a long pause, then sometimes one more strong beat and then a pause. Sometimes there are longer pauses, at other times I feel every beat fairly strong for eight or nine beats. The pulse is 48.

DR. CHRISTIAN: I do not know whether you thought a good many of the beats were strong beats, or did you say you felt some weak beats or not?

STUDENT: I did feel weak beats every now and then.

DR. CHRISTIAN: How did those weak beats come in relation to the strong ones?

STUDENT: To me they seemed to come after the pause. There would be a strong beat, then a pause, then a strong beat, and then the next two or three beats would be weak.

DR. CHRISTIAN: Did you feel any other weak beats?

STUDENT: Just then I felt a rather accelerated beat.

DR. CHRISTIAN: The heart is beating along with pulse-waves of about the same character, and then very shortly after one of those normal pulse-waves you can every now and then feel a very faint pulsation. It is just detectable to the palpating finger. Then it may go along for quite awhile, as you described it, quite regularly, all the beats of the same size and about evenly spaced. It has been some time now since I felt one of those little beats. As I feel it now it is beating quite regularly and beating at a distinctly slow rate. I felt then just a little beat. You felt a succession of small beats. Since I have been following it I have not felt that. I do not doubt that at times that is present, but it happens only very occasionally. At times you get a much weaker beat, and then a little bit more of a pause, and that is repeated several times, and then you get periods in which you get just a succession of rather normal beats, apparently quite regular and at a slow rate. Then there are periods when, as you described it, I did not feel it, there is quite definite irregularity and a succession of quicker beats, irregularly spaced, some smaller and some larger, but, in general, weaker than those recorded before. That is probably what is going on. It is a heart that varies quite a good deal in its succession. Sometimes such an irregular beat as that coming on shortly after a normally spaced beat is an ectopic beat; it is an extrasystole originating from some point or other in the heart. Its strength varies with time relations. If it comes quickly after a strong beat it comes at a point when two things are happening in the heart. First the heart is filling up and necessarily contains very little blood, and consequently if it comes when contraction has taken place recently it can make only a small pulse-wave because the systolic output is very small. Or if it comes close to the regular beat it strikes in the fag end of the refractory phase, and whereas the heart

muscle responds to the stimulation, it does not respond with a very forcible contraction. Those two things together give a small pulse-wave.

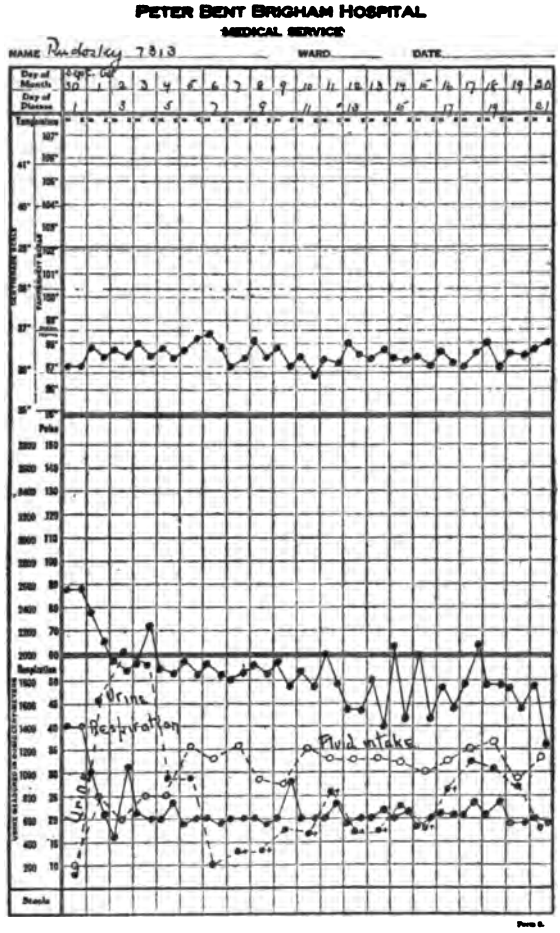

Fig. 85.—Chart of patient No. 7313. *Diagnosis:* Auricular fibrillation with heart-block produced by digitalis. Note the decrease in pulse-rate and the diuresis following digitalis.

DR. CHRISTIAN: (to student): Won't you listen to the heart to see if there are any murmurs?

The point of interest in this patient's chart (Fig. 85) is that when she came in her pulse was running at a rate of 90, and

then dropped on the third day to 60 or less, and it has been below 60 ever since she has been in. It has been counted down as low as 45 and 40 in the last few days, so that she has had a slow pulse since she has been in the hospital. I will read the description of her pulse when she came in: "The pulse-rate was 90 per minute, pulses equal, very irregular in force and rhythm. Vessel wall not palpable." You see there was no dominant rhythm. It was absolutely irregular and on the basis of that absolute irregularity the patient was diagnosed as having auricular fibrillation—I mean by the pulse observation.

What do you make out in the way of murmurs?

STUDENT: The first sound seems to be rather distant. The second sound has a rolling character to it as if it were reduplicated.

DR. CHRISTIAN: You have really put the cart before the horse. You have mixed up those two sounds. The first sound has the rolling or rumbling quality. The second sound is short. The rumble is with the first sound. Did you listen at the base? Were there any murmurs there?

STUDENT: In the aortic area I heard a systolic murmur.

DR. CHRISTIAN: Did you feel anything?

STUDENT: I felt a thrill.

DR. CHRISTIAN: Yes, those are the main points. I do not want to go into the discussion of valve lesions. Here is a patient with a perfectly definite abnormality of her heart sounds with a thrill and murmurs. It happens she has a systolic thrill that is pretty intense over the base of the heart accompanied by a harsh systolic murmur. She has also in the same region a prolonged diastolic murmur. In the apex region she has just a slight thrill, presystolic in time, has a rumbling first sound, and a blowing systolic murmur. She has, as far as her valves go, the signs of aortic stenosis as the most striking thing; with the stenosis is aortic regurgitation. There are signs at the apex that are suggestive, but are not exactly diagnostic, of a mitral stenosis. She also has a regurgitation through the mitral valves or mitral insufficiency. I say "suggestive" and not "diagnostic" because of the possibility of it being the Austin-Flint type of

murmur, which we find, according to the text-books, associated with aortic insufficiency; according to our own idea here we do not take much stock in Austin-Flint murmurs. When the murmur is quite definite we call it mitral stenosis, and we have pretty good reason to think that under those circumstances we are quite correct, because when we get a chance to view the heart we find stenosis present in proportion to our finding the signs of it. We very rarely make a diagnosis of an Austin-Flint murmur.

She has an enlarged heart with valve lesions. When she came in she had this absolutely irregular pulse which we regarded as due to auricular fibrillation. When she first came in we gave her a brief period of digitalis and her pulse became quite regular. There was no longer any variation in the time between succeeding beats. They were all of the same character as far as the strength of the pulse-waves were concerned. When we studied them with the electrocardiograph (Fig. 86) we found that the ventricles were beating perfectly regularly and that the auricles were not beating at all except in fibrillation. All that could be seen in that electrocardiogram would be a ventricular complex, then a string that did not do anything except have a lot of fine movements in it, little fibrillary twitchings, until the ventricular complex was repeated. That is a different kind of heart-block. This patient is at this time in complete heart-block. Complete heart-block has been produced therapeutically in all probability; that is, by giving digitalis we have decreased the irritability of the conduction system so that it no longer conducts the various types of impulses sent out from a fibrillating auricle. The auricles continued fibrillating just as they were before, the ventricles were beating at a more even rhythm, and that was a rhythm most of the time between 50 and 60, perfectly regular, and the patient was very comfortable. After a time the block did not persist and in the last day or two we have had what was described here—occasionally an extrasystole and occasionally periods in which the heart was absolutely irregular as described; that is, a succession of quicker beats, varying in intensity and vary-

ing in the space between each successive beat; in other words, a heart partially out of block. I have one electrocardiogram

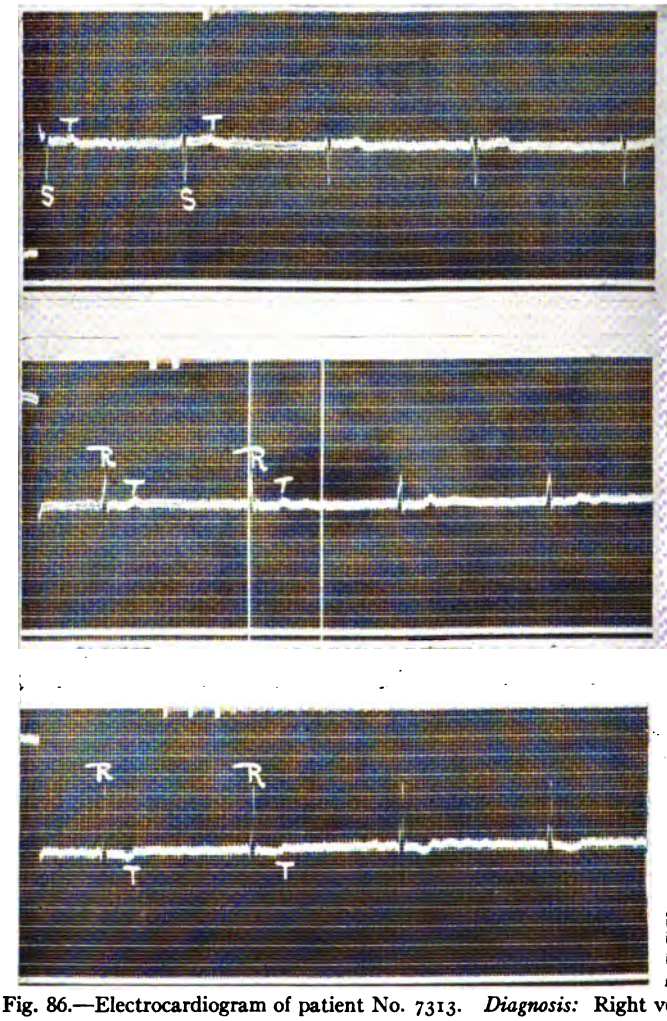

Fig. 86.—Electrocardiogram of patient No. 7313. *Diagnosis:* Right ventricular hypertrophy; auricular fibrillation; complete heart-block. *R* and *S* indicate the wave of the beginning of ventricular activity; *T* wave marks its end. Note the absence of *P* waves and the regularity in rate in the occurrence of the *R* and *S* waves.

(Fig. 87) here that just happened to catch an ectopic beat and that is in the middle one of these three tracings. You will

notice a regular slow rate except at one point when it was interfered with by the ectopic beat. That is a different kind of ventricular complex coming closely after the regular one and

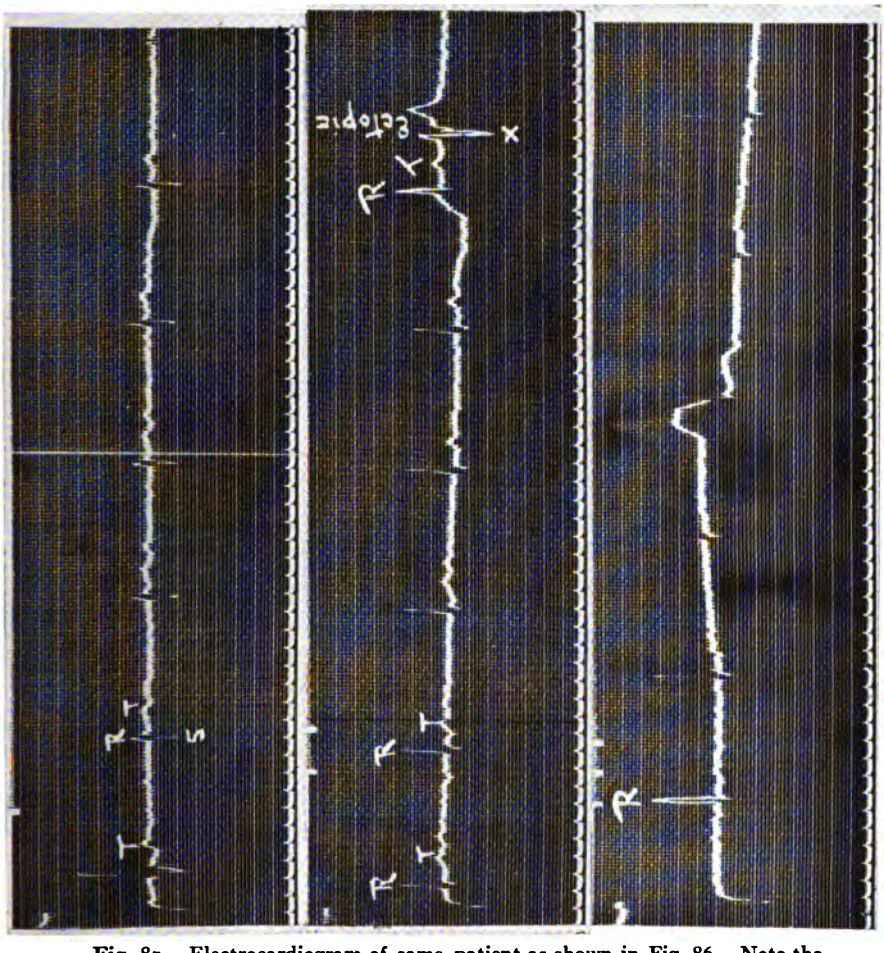

Fig. 87.—Electrocardiogram of same patient as shown in Fig. 86. Note the regularity in the recurrence of the *R* and *S* waves, the absence of *P* waves, and at *X* an ectopic contraction of ventricular origin. Note in this the difference in form from the preceding *R* and *T* complexes.

of an abnormal form and consequently an ectopic beat. We recognize that as an ectopic beat because of this abnormality

in form. You see it is in a different direction from these other regular ones. It is longer than the other regular ones and has an exaggerated "T" wave. It comes shortly after the regular "R" wave, but does not particularly disturb the rhythm. Here is a condition of transitory complete heart-block in a patient with auricular fibrillation, and it is produced, as I say, probably by digitalis. It did not exist when the patient came in. We gave the patient a short course of digitalis. Her heart went into complete block and remained regular for five or six days, and then the irregularity that she formerly had began again to make its appearance. We see that very often; we produce the block therapeutically.

I want to contrast the three cases of heart-block (Clinics of October 8th and 16th) from this point of view. The first patient (P. B. B. H., Med. No. 7345) had complete dissociation and had the symptoms of dizziness, the lesion probably was of syphilitic origin, as he certainly had syphilis. The second patient (P. B. B. H., Med. No. 7374) had a regular heart-rate most of the time with delayed conduction time, and occasionally as the result of exercise or a strain his heart went into partial block, and when it went into partial bock he had what he described as a flash of darkness, and on one occasion, presumably when it remained in block for a longer time, he lost consciousness. He became unconscious, but did not have any convulsions. In so far as loss of consciousness in this definite attack goes he has Stokes-Adams syndrome in association with heart-block. After a time he developed complete block, and later this disappeared and he returned to a regular rhythm with delayed conduction time. Both of those patients are uncomfortable in relation to the block, the kind of the block, the amount of the block, etc. The other patient (P. B. B. H., Med. No. 7313) with auricular fibrillation is comfortable when her heart is in block and uncomfortable when her heart is out of block. The third case of block was produced therapeutically, the result of producing the block is getting her heart going regularly at a rather slow rate and with a ventricular contraction with each beat a functioning beat in the sense of a good systolic output. When she

has that her circulation is better and she is more comfortable. When she passes out of block this fibrillary twitching in the auricle begins to effect the rhythm of the ventricle and changes the rhythm from a regular slow rhythm to an irregular rhythm, and as the block disappears to a faster rhythm. With that irregular rhythm some of the beats are of too little force to make much of a systolic output, many of the beats come out of time when there is not very much blood in the ventricles, and consequently the systolic output is small. That patient is uncomfortable just in ratio as the block decreases. The other patients you might say are uncomfortable just in ratio as the block goes the other way—the more block, the more uncomfortable; in the fibrillating case the more block, the more comfortable.

We see a good many cases in which varying degrees of heart-block are produced by digitalis in these fibrillating hearts. That is the way to treat the heart, and our treatment is successful in so far as we can produce and can maintain a certain degree of block, not necessarily a complete block. This happens to be a case who is comfortable only when her heart is in complete block. The etiology in this last case I think is rheumatism and tonsillitis causing a valve lesion in the heart, and gradually with the valve lesion there has developed a myocardial disturbance—myocardial insufficiency—and that has gone on for a certain length of time, how long we do not know. The patient had cardiac symptoms ten years ago. In some period in the last ten years her heart ceased to beat regularly and started to be irregular; in other words, auricular fibrillation started with extrasystoles coming in. Just recently she has had a break in compensation and probably that was the time when her heart began to fibrillate. It is in fibrillation now and probably will stay in fibrillation, although she may be made quite comfortable under doses of digitalis to maintain the heart-block.

CHRONIC MYOCARDITIS

October 22, 1917.

DR. CHRISTIAN (to students assigned to cases): I wish you would examine the heart as to size, murmurs, and rhythm, and the pulse as regards tension, volume, rhythm, and condition of the vessel wall.

CASE I

DR. CHRISTIAN (to student): What did you make out (P. B. B. H., Med. No. 7377)?

STUDENT: The heart is enlarged. The apex is in the fifth space, well outside the nipple line. A diffuse apex-beat is seen there.

DR. CHRISTIAN: The heart shows enlargement to percussion out to that point. The right border is 2½ cm. to the right of the midsternal line.

STUDENT: When I first examined the heart the rate was very slow—about 32—but subsequently it increased, and is now 64 at the apex, but occasionally one beat does not come to the wrist. The heart is irregular both in rhythm and in strength. The stronger beat is followed very quickly by a weaker beat which may or may not be felt at the radial. There is a marked systolic murmur best heard at the apex, but heard in the axilla and heard slightly at the aortic and very slightly at the pulmonic areas. The sounds at the pulmonic area are less intense than at the aortic.

DR. CHRISTIAN: What did you take to be the apex-beat? (Indication by student.) Feel a little further out and see if you do not get any. You can get a distinct impulse out further than you have described it—out to where my fingers are; that is, the apex-beat is outside the nipple line. You have got to be very careful in some of these cardiac conditions not to overlook the real position of the apex-beat. Occasionally there will

be apparently a perfectly distinct apex-beat in the normal position, and you take that for the apex-beat and go no further. Then if you go ahead and look out in the axilla you find another beat out there. In other words, a point of vigorous impulse is in about the normal region of the apex-beat, but the ventricle goes further out, and you necessarily feel an impulse out there. You can feel out in the axillary line a distinct apex-beat. The heart is larger than you described it.

STUDENT: I could not percuss the cardiac area satisfactorily.

DR. CHRISTIAN: Sometimes these hearts do not cause any dulness at all if the patient has a good deal of emphysema. It is not always easy to make out definitely the border by percussion, particularly if you percuss rather hard. That is a mistake that is sometimes made by men with longer experience than yourself. They say the heart is of normal size on the basis of finding a perfectly good impulse, normally localized, and do not look further out. This patient has a large heart, but not a very much enlarged heart, however. What would you say about the irregularity?

STUDENT: The beats seem to be grouped. There is a strong beat which will then be followed by a weak one. The sounds are weak.

DR. CHRISTIAN: Are those groups of two or three or any fixed number?

STUDENT: Either two or three.

DR. CHRISTIAN: Yes, there is a distinct tendency to grouping, there being one, two, or three quick beats and then long pauses. There is audible a systolic murmur of moderate intensity. It is heard pretty generally over the precordium, but loudest at the apex. Now look and see how much of an impulse you can see. I think you can see distinctly an impulse at about that point. How about his peripheral vessels?

STUDENT: I do not think they feel particularly sclerosed; they feel soft.

DR. CHRISTIAN: Yes, those are vessels of about normal consistency. The radial is soft. When you roll it under

your finger you can feel it, but it is not particularly thickened. The brachial indicates a little more thickening, but it is not a very abnormal vessel. There is a very moderate degree of sclerosis.

CASE II

DR. CHRISTIAN: We will now take up the next patient (P. B. B. H., Med. No. 7311). What did you make out?

STUDENT: This man's pulse is about 53. His radial artery shows signs of sclerosis—I felt hard masses in it. The tension seems to be rather high. The pulse is of fairly good volume.

DR. CHRISTIAN: There is distinctly an irregular, so-called beaded type of artery. In running your finger up and down you find that it is not very large, but your finger runs over definite irregularities in the vessel where the vessel is thickened, and there are places of about normal consistency. They are not very large vessels. What about his heart?

STUDENT: I find dulness in the nipple line and 3 cm. to the right of the midsternal line. The apex-impulse is of fair intensity about in the nipple line, but you can feel it out well into the axilla.

DR. CHRISTIAN: How far?

STUDENT: Out to the anterior axillary line.

DR. CHRISTIAN: The impulse is a little low. It is not normally placed, but it is only a little outside of the nipple line. What did you hear?

STUDENT: I did not hear any murmurs. The first sound was rather sharp.

DR. CHRISTIAN: The first patient has almost normal peripheral arteries for his age. The second patient has distinctly thickened arteries of the beaded type.

CASE III

DR. CHRISTIAN (to student): Tell us what you found (P. B. B. H., Med. No. 7349).

STUDENT: When I first examined the pulse the rate was about 46, regular and even, but not strong. When I examined it about five minutes later it was beating at about 78, at about

the same strength and regularly. The heart sounds are distant and not very clear. I did not hear any murmurs and the heart did not appear to be enlarged, though it was difficult to make out the apex-beat. The apex-beat is apparently about in the nipple line. The arteries are a trifle sclerosed, not markedly so. The carotid impulse is not marked.

DR. CHRISTIAN: Here again the apex-beat is a little bit further out than described. It is about a fingerbreadth, or possibly a little bit more, outside the nipple line. As you go along with your fingers you feel at about that point practically no impulse, and then inside that quite a definite impulse. In these cases with hearts that are enlarged or dilated the point to take as the apex-beat is the outermost point at which you get a distinct palpable pulsation—not the point at which you get the maximum, because, as I have just said in talking about the other man, sometimes you get the definite impulse 3 or 4 inches inside the left border of the heart. On the other hand, it is not the point furthest out at which you can feel some impulse, because when the enlarged heart pulsates it lifts the chest wall and that lift can be palpated sometimes, particularly with a heart beating forcibly, far beyond what you would say was the left border of the heart as made out by percussion or fluoroscopic examination, so there is a certain personal equation—not the furthest point at which you can feel any impulse, not the point at which you can feel the maximum impulse, but the outer border of a definite impulse. I take it that all three of the gentlemen have tended to underestimate the position of the apex-beat in these cases.

STUDENT: The artery is a little thickened.

DR. CHRISTIAN: It is a little diffusely thickened. The artery in this patient is different from that in the other two. In the first place it is not irregular; in the second place it is a small arterial vessel and as you roll it under your finger there is very definite thickening. As you listen over the heart there is a systolic murmur of very slight intensity and the pulse becomes every now and then regular, and at other times it is irregular. Most of the time when I was listening there it was quite regular. The irregularity when it occurs consists in a weaker beat com-

ing at a shorter interval after the beat of ordinary strength. Did you get any period when you were feeling or listening when there was definite irregularity?

STUDENT: I think the rate was 46 when I first counted it, and then 78. I did not get any transition between the periods.

DR. CHRISTIAN: Keep feeling the pulse and you may catch an irregularity. Most of the time it is regular.

CASE IV

DR. CHRISTIAN (to student): What did you make out in the patient's pulse (P. B. B. H., Med. No. 7394)?

STUDENT: The pulse was irregular at about 85 to 90 per minute. The irregularity consisted in dropped beats. These occurred most frequently once in five, with once in thirty-five as the least frequent. The pulse in general is not very full in volume nor very strong in intensity. The arteries seemed normal.

DR. CHRISTIAN: The arteries are essentially normal ones. They are of normal size, normal volume, and normal tension, and do not roll under your finger any more than you would expect to feel the radial artery.

STUDENT: Very occasionally one of the beats seemed to be longer than those either preceding or following it.

DR. CHRISTIAN: Where did you locate the left border and the apex?

STUDENT: I located the left border 14 cm. from the midsternal line. The apex-beat is rather diffuse. It takes in an area way down here, and when he happens to be sitting just right you can see it down as far as the epigastrium. It is most marked 10 cm. from the midsternal line and a little inside the nipple line, but the cardiac impulse can be felt very distinctly about 14 cm.

DR. CHRISTIAN: What did you hear?

STUDENT: The sounds are not very audible; particularly those at the base. At the apex you get a very distinct systolic murmur taking up the whole of systole. This is transmitted to the axilla and really to the posterior border of the axilla, but

it becomes very faint by the time you trace it that far. At the apex the second sound is distinctly louder than the first. The sounds over the aortic area are quite indistinct. Here, I think, there is a little systolic murmur, probably the same that is heard over the apex area, and the aortic second sound was not very easily heard. Over the pulmonic area the pulmonic second was distinctly louder than the aortic second. The patient breathes pretty largely with the left lung, I should judge, and the noise of respiration tends to obscure the sounds at the base.

DR. CHRISTIAN: Which sound did you say was the loudest at the apex?

STUDENT: The second sound was louder than the first, particularly listening over this area. Neither sound was very loud.

DR. CHRISTIAN: You see the first sound is very largely obscured by the murmur. You can hardly hear the first sound. It is almost replaced by the systolic murmur. You did hear quite distinctly the second sound. The second sound is of normal quality and the first sound is very largely lost. Neither one of the sounds are loud, however, either at the apex or at the base.

STUDENT: The last sound before the skipped beat is louder than the others. I do not know whether that is the interpretation that I give it or whether it is really so.

DR. CHRISTIAN: Very often the sounds when a beat drops out are of different intensity. While I was listening none dropped out, so I cannot say whether there was any change in sounds or not.

CASE V

DR. CHRISTIAN (to student): Tell us what you make out in this patient (P. B. B. H., Med. No. 7282).

STUDENT: His pulse is regular—68 to the minute. There seems to be considerable tension and the artery is tortuous and fibrous, but does not feel calcified.

DR. CHRISTIAN: It is distinctly thickened, is tortuous, but is pretty smooth. Then in regard to his apex?

STUDENT: You can feel the impulse and see it way out into

the axilla. It is about 14 cm., I should think, from the midline—you have to chase it around the corner.

DR. CHRISTIAN: Yes, the impulse goes around the corner—his chest goes out and then almost turns at right angles. You can feel a big impulse out in the axilla. Where you locate the apex-beat by percussion depends on at what angle you percuss and how you percuss. Here is a rounded chest wall, and the heart is in pretty close contact with the chest wall until you get far back. If you percuss at right angles to the chest wall in the axilla you percuss out the posterior border of the heart. If you percuss in an anteroposterior direction you percuss out the left border of the heart more accurately, but practically the heart goes as far to the left as the chest wall goes. In other words, with that shaped chest and a heart that large, percussion gives you a pretty imperfcet idea of increase or decrease in the size of the heart, and I guess if six or eight of us located that left border we would all locate it differently. The essential point is that it is a much enlarged heart, so much so that the left border is out in the axillary region. That is just the kind of a heart that you cannot measure the size of. It may get larger and not change much in position. Already it has gone out to the left in the lateral position as far as it can go. If it gets larger it will occupy more and more of the pulmonary space. It will spread more to the back and then more to the right.

DR. CHRISTIAN (to student): What did you hear?

STUDENT: The second sound is heard loudest at the apex. There are no murmurs. Twice I detected, or thought I did, an irregularity. A^2 is about like P^2 at the base.

DR. CHRISTIAN: Here we are dealing with a heart much enlarged, a patient with peripheral arteriosclerosis as evidenced by tortuosity and uniform thickening of the vessels. Notwithstanding the large size of the heart there is almost no murmur audible anywhere. There is a little bit of a systolic blow at the apex. It is essentially a heart without murmurs, there being just this slight blowing systolic murmur.

CASE VI

DR. CHRISTIAN (to student): Tell us what you made out in your patient (P. B. B. H., Med. No. 7358).

STUDENT: The pulse is beating at the rate of about 90 and has not a very great volume. The arterial wall is moderately hardened.

DR. CHRISTIAN: Is it smooth, or uniform, or irregular?

STUDENT: It is smooth.

DR. CHRISTIAN: Yes, here is another case in which the vessel is thickened—the radial artery—but it is uniformly thickened. It is not particularly tortuous, not as much changed as the preceding man's. How about the size of his heart?

STUDENT: The heart is considerably enlarged. On inspection the impulse is seen in the fifth or sixth interspace possibly. On palpation I think I felt it most prominently in the fifth interspace. It can also be felt in the sixth. On percussion the heart is about an inch or so outside the nipple line.

DR. CHRISTIAN: Here again it is somewhat as in the preceding patient, the apex-beat has gone well out toward the axilla, not as far as in the preceding case, but well out. The impulse is very diffuse, so it is a little hard to say just what you would call the outer border of the apex-beat, but it is well out and certainly out as far as the anterior axillary line. What else did you make out on percussion and auscultation?

STUDENT: The heart is slightly enlarged to the right also. The cardiohepatic angle is acute. On auscultation there is a presystolic murmur and a reduplicated second sound followed by a short diastolic murmur.

DR. CHRISTIAN: Yes, that is present and there is a little thrill with the presystolic murmur. The heart is enlarged and there are some signs of sclerosis and some signs of valve lesions.

CASE VII

DR. CHRISTIAN (to student): What did you make out in your patient (P. B. B. H., Med. No. 7407)?

STUDENT: The pulse is between 60 and 70, irregular at times

and regular at other times. The irregularity seems to bring in more weaker beats. The tension is not very high.

DR. CHRISTIAN: Is the wall thickened?

STUDENT: The wall, I should say, is a little thicker than normal, but not markedly thickened.

DR. CHRISTIAN: Did you feel the brachial?

STUDENT: No.

DR. CHRISTIAN: Well, you will notice that the brachial is considerably thickened. Where you usually feel the pulse in this particular patient the vessel is not particularly thickened, but if you run your finger up the vessel to the midarm you find the brachial becomes very distinctly thickened and a little tortuous. The brachial is very considerably thickened there. That happens sometimes when you feel the pulse just at the wrist, whereas the vessel may be markedly thickened higher up. It is always important in feeling vessels to run your fingers up along the vessel, feeling both in the forearm and in the upper arm. You will sometimes miss evidence of considerable sclerosis if you feel the pulse in the usual way. Here there is nothing particularly abnormal about the vessel at the ordinary place of feeling the pulse. Just a little above there is distinct thickening and also a little tortuosity. What did you make out in his cardiac area?

STUDENT: The impulse comes in a large area in about the fifth or sixth interspace, and goes out to the left about 13 or 14 cm.

DR. CHRISTIAN: You have a diffuse impulse occupying a considerable amount of space and coming pretty well out toward the anterior axillary line. What do you hear?

STUDENT: There is a loud blowing systolic murmur heard at the apex, more or less replacing the first sound.

DR. CHRISTIAN: It is a loud blowing systolic murmur, rather high pitched, and you might say it was a little musical. Are there any other murmurs?

STUDENT: No.

DR. CHRISTIAN: The systolic murmur is transmitted to the axilla and also up along the sternum.

DR. CHRISTIAN: I brought over this group of patients because they all illustrate pretty much the same type of cardiac disturbance. I simply brought these men—there are, I guess, nearly as many women on the women's ward illustrating just the same thing—to give you an idea of the frequency of patients with a certain type of cardiac disease. You see most of them are adults approaching middle life. Some are younger, some are older. They are not young people, and as given in their histories the majority of them are people that have not had any history of acute rheumatism. There is an indefinite history in one, a definite history in another—still in most not a typical articular rheumatic type of history. They are all people who have worked pretty hard, and all people, with the possible exception of one or two, that gave a pretty marked alcoholic history. None of them had positive Wassermann reactions—they are all negative. By no means have all of them arteriosclerosis. Some of them have for the average of their age pretty normal peripheral arteries, so that arteriosclerosis is not a common finding. Their symptoms have varied. They represent the various types of cardiac decompensation symptoms that I have referred to. They have different types of shortness of breath, some with pain, some with anginal-like pain. One of the patients has a history of considerable weakness, and that is said to be his most prominent symptom. He had shortness of breath, etc., but there was this story of weakness. In regard to the types of arhythmia, etc., we will speak at the next time. While they are here I would like you to take this opportunity to come down. Do not bother to try to make out the size of the heart, but listen to the sounds. Go from one to the other, and note the different types of muscle sounds and the different types of murmurs. With the exception of the man here, the patients have nothing but varying forms of systolic murmurs. This other patient has a presystolic murmur. Feel the type of pulse, the thickness of the artery, etc.

October 23, 1917.

DR. CHRISTIAN: This afternoon I am going to discuss the cases that I showed yesterday a little bit more in detail than

we had time for then. First I want to run over the main points in the histories and physical examinations of those cases.

CASE I

The first patient (P. B. B. H., Med. No. 7377) was fifty years of age. He did hard, laborious work and drank alcohol to excess. He had pneumonia when he was twenty-one years of age. He had no other acute infectious diseases. Six years ago he had swelling of the feet and shortness of breath. That, however, did not stop him from work. He worked until a week before he came into the hospital. However, for three months he had been very weak and very short of breath. He had edema of the legs and pain in the abdomen. The student who went over him found that he had some irregularity of his heart-rate; found his heart was enlarged, his impulse being out to the left beyond the nipple line, and that his radials were of about normal make-up. There were no definite signs of sclerosis. When the patient came into the hospital he had a moderate increase in his blood-pressure from the point of view of our hypertension cases, $\frac{165}{110}$,[1] and he had a heart which was percussed 14.5 cm. to the left of the midsternal line and 5 cm. to the right. That was on October 10th. On October 13th he was 13 cm. to the left and 5 cm. to the right. His blood-pressure on the 15th had fallen to $\frac{115}{80}$. When he came in he had, I think, essentially what was made out on the examination here as far as symptoms were concerned. He had a loud systolic murmur at the apex transmitted to the axilla, and that is what we made out here in the clinic. There was an audible systolic murmur of moderate intensity heard pretty generally over the precordium and loudest at the apex. In regard to his pulse the rhythm was described as being irregular, and there was a tendency to grouping of the beats, one, two, or three coming close together, then intervals, and another group of one, two, or three quicker beats—no dominating rhythm.

Here is an electrocardiogram (Fig. 88) taken yesterday

[1] The figure above the line is the systolic blood-pressure, the one below is the diastolic blood-pressure.

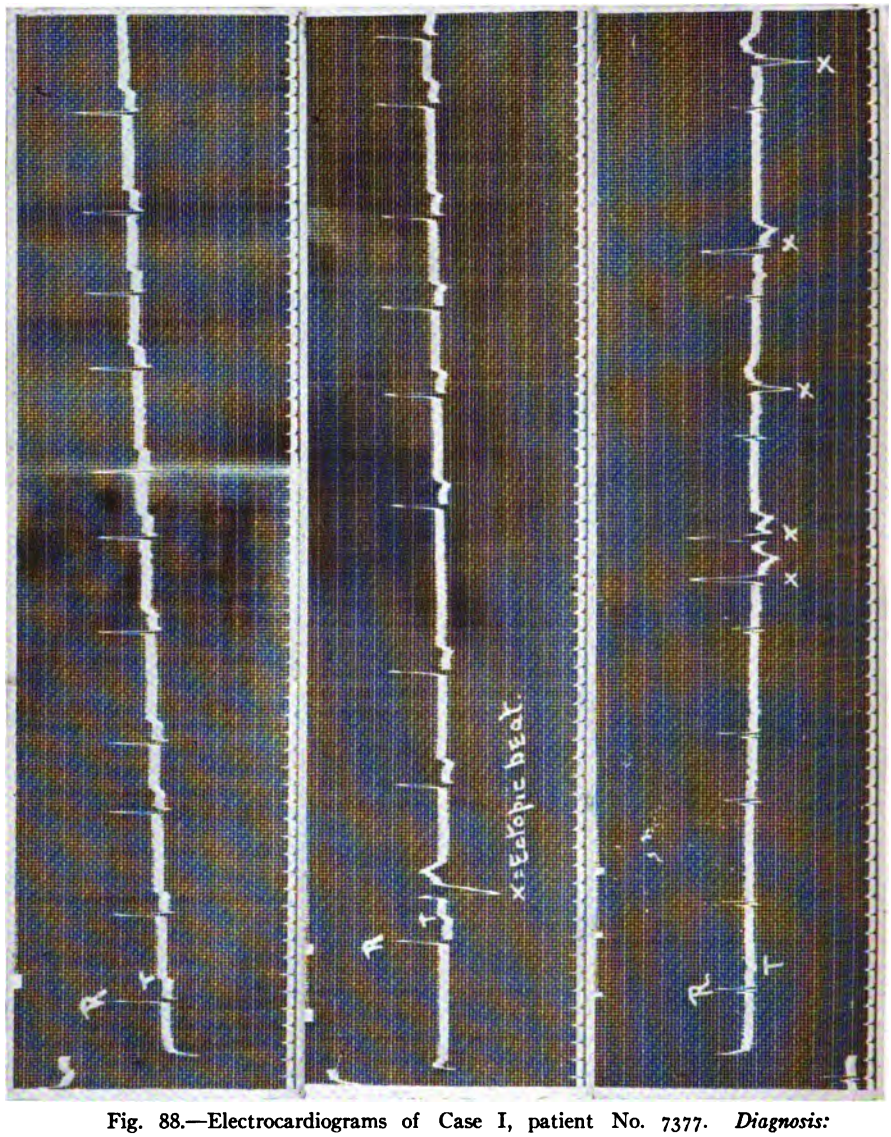

Fig. 88.—Electrocardiograms of Case I, patient No. 7377. *Diagnosis:* Auricular fibrillation; premature ventricular beats from two separate foci. Note the variation in the interval between waves of the type marked *R*, the absence of *P* waves, and at the points marked *X* waves of different forms. These are ectopic beats of ventricular origin and, being of different forms, indicate several foci for their origin.

afternoon after the patient left the clinic, and shows what was described. You will see as it is passed around that there are three beats fairly closely spaced together, then two with longer intervals, then shorter intervals, then longer intervals, and then two shorter ones. They vary in different leads. There is quite a long diastolic pause followed by a little bit shorter one, then two or three quicker beats, and at one point the rhythm is interrupted by an extrasystole. In another lead there are two extrasystoles coming close together of one origin, and then later on there are two or three extrasystoles that start at some other point in the ventricle. One of these starts in the right ventricle and the other starts in the left ventricle. There is no definite muscle preponderance on one side or the other, but the patient has fibrillation, an absolutely irregular pulse, and as you look along the curve there are no signs of definite "P" waves.

CASE II

DR. CHRISTIAN: The next patient (P. B. B. H., Med. No. 7311) is fifty-nine years of age. He was engaged in hard work, drank alcohol to excess. Eight months ago he had some sort of trouble in his feet, not made out to be definitely an attack of rheumatism, and was probably a combination of flat-foot and some edema from his cardiac condition. Apparently he had no fever and it did not involve other joints. It may have been rheumatism, but probably was not. A year ago he began to have shortness of breath on exertion and got dizzy when he stooped over. Nine months before he came in he had a definite attack of cardiac decompensation, swollen legs, distended abdomen, was markedly short of breath, and had nocturnal paroxysms of dyspnea. He got over that attack and was able to work for six months. Three months before he came in he began to get worse, his feet became swollen, his shortness of breath increased, and after about a month he had to cut down largely on the amount of work he did. He began to have nocturnal dyspnea. Two or three times with the dyspnea he had pretty severe pain. The pain radiated down the left arm and into the epigastrium. A small amount of concentrated

urine was passed. That patient, as far as the pulse went, showed quite a marked degree of sclerosis. He was the one with the

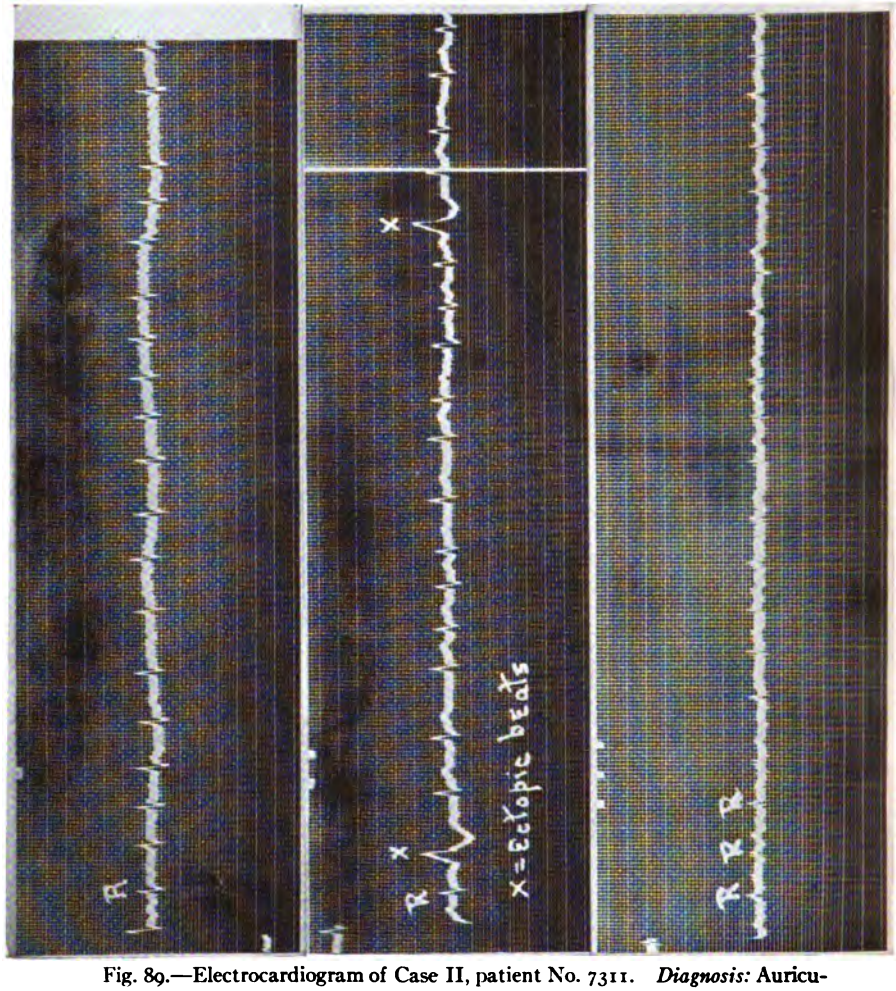

Fig. 89.—Electrocardiogram of Case II, patient No. 7311. *Diagnosis:* Auricular fibrillation; ventricular extrasystoles. Note the irregularity in the rate of recurrence of *R* waves and at the points marked *X* the occurrence of ectopic beats. No *P* waves occur.

small beaded type of artery. He had a cardiac enlargement, the apex being somewhat outside the nipple line. The gentleman who went over him thought he heard occasionally a suggestive

systolic murmur at the apex, but not a very striking murmur; that is, the murmur played a very small part in the physical examination. When he came in he had a blood-pressure of $\frac{170}{100}$. He had cardiac enlargement, the left border being 13.5 cm. to the left and the right border 4 cm., you see not as large a heart quite as the other one, but not very different. That was on the 29th of September. On October 7th the blood-pressure had fallen to $\frac{135}{90}$, cardiac manifestations were essentially the same. That patient's pulse-rate was distinctly irregular, and on studying it we find that, like the other patient, there is absolute irregularity with an occasional extrasystole (Fig. 89). No "P" waves were made out. There was a considerable amount of vibration in the string and only a very occasional extrasystole. You will notice an occasional abnormal beat as the curve is sent around. Again, that is a case of auricular fibrillation.

CASE III

DR. CHRISTIAN: The third patient, the negro (P. B. B. H., Med. 7349), is thirty-six years of age, a moderate user of alcohol, a heavy worker—having worked in a foundry. He had grippe and rheumatism five years ago. That was perfectly typical acute articular rheumatism affecting many joints. Four to five months before he came into the hospital he noticed that he got tired very easily. He got short of breath on very severe exertion. Two months before he came in fatigue was sufficient to interfere with his work, and he found that he could not keep up the pace with the rest of the gang. At work he got very short of breath. After stopping work he did not become very short of breath until about a week before he came to the hospital, and that was accompanied, as he described it, by his being "sick at his stomach." Five days before he came in he himself noticed his heart beating in an irregular fashion. He had, as we went over him, a slight degree of thickening of his arteries uniform in character. He had a moderate degree of diffuse arteriosclerosis. His heart was enlarged to a moderate extent. When he came in on October 5th he had a blood-pressure of $\frac{160}{75}$ and on some days a systolic pressure of only 130. His heart measured 14 cm. to

the left and 3.5 cm. to the right. The first sound was replaced by a blowing systolic murmur heard well out into the axilla. He

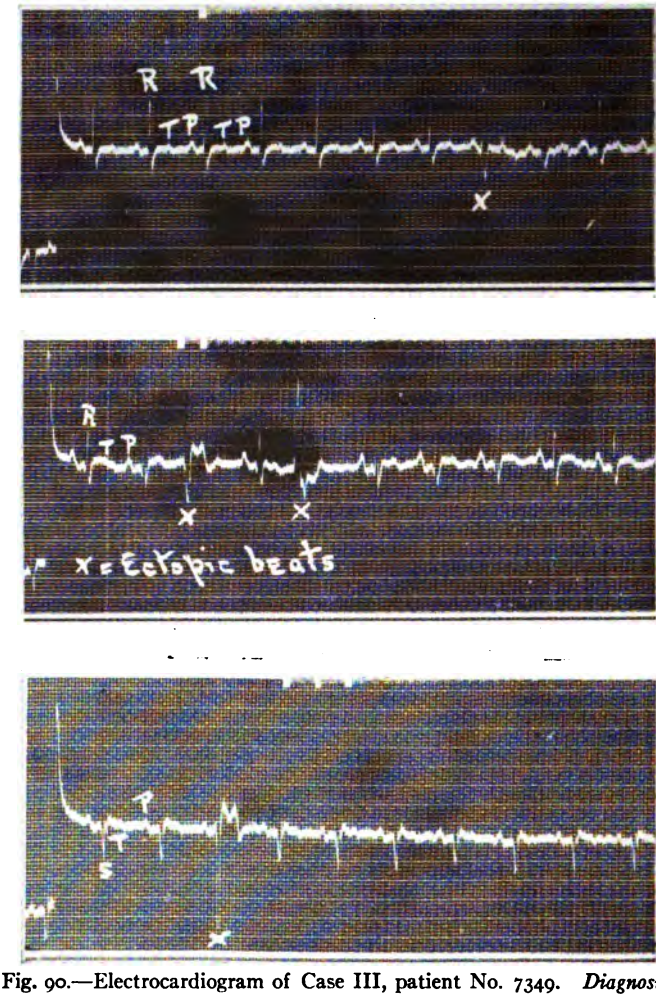

Fig. 90.—Electrocardiogram of Case III, patient No. 7349. *Diagnosis:* Left ventricular hypertrophy; ventricular extrasystoles. The waves of the ventricular complex are indicated by *R* and *T*, and the auricular impulse by *P*. There is a normal relation between the auricles and the ventricles, and at the points marked *X* occur ectopic beats of varying points of origin which interrupt the regular rhythm.

had a definite gallop rhythm to his heart. No other murmurs. On the 11th his heart outline was 5.5 cm. to the right and 13

cm. to the left, and the same harsh systolic murmur was heard. His pulse was, for most of the time, regular. While we were going over him before the class once or twice a small beat was felt shortly after the normal beat. After the class came down and began to go over the patient his pulse became quite irregular and the irregularity consisted in the occurrence of a weaker beat at a shorter point than the normal relation after the regular beats. The electrocardiogram (Fig. 90) confirms that by showing an occasional extrasystole. Otherwise the ryhthm is quite normal and the complex is quite normal as far as the "P," "R," and "T" waves are concerned. That is, the auricle is not in fibrillation, it is beating regularly, and with the exception of the extrasystole the ventricles are in normal response to the stimulus coming down from the auricles. It shows the complex of left ventricuar hypertrophy. This is left preponderance, and in the first lead the main ventricular complex is up and in the third lead it is down, which is characteristic of left ventricular preponderance.

CASE IV

DR. CHRISTIAN: The fourth patient (P. B. B. H., Med. No. 7394) is forty-two years of age. He used alcohol in considerable amount, but not as much as the preceding man. He worked rather hard, but did not do the laborious type of work that the other people did. He was a fruit peddler and, I guess, pushed his cart, and that is not easy work. He had had no acute infections at all. A year before he came into the hospital he woke up suddenly one night with a severe pain in his chest and that pain kept up for about two days. It responded to treatment, and he was all right until eight weeks before his admission, when he again had pain in his chest and shortness of breath. The pain quickly disappeared, but the shortness of breath persisted, and he came into the hospital on account of the shortness of breath, with the added symptom that if he stooped down or exerted himself in any way he had a sensation of pressure in his chest—not actual pain. He had an irregularity consisting of dropped beats, according to the student who went over him, not coming very frequently; once in five, sometimes as infrequent as once

in thirty-five. He had essentially normal arteries. The heart was enlarged, the left border being 14 cm. to the left. He had a diffuse pulsation all over the precordium and down in the epigastrium, and a systolic murmur heard at the apex, transmitted well out to the axilla, etc. He had a blood-pressure of $\frac{135}{90}$ when he came in, and that was on the 14th of October. His heart was percussed 2 cm. to the right and 15 cm. to the left. He had a soft systolic murmur heard over the apex; no other murmurs heard. On October 15th cardiac measurements were 4.5 cm. to the right and 14.5 to the left.

The electrocardiogram (Fig. 91) from this patient shows first a normal relation as far as the auricles and ventricles are concerned, an occasional extrasystole, representing the dropped beat made out by the student that went over the case, and then all of the complexes are abnormal, not having the usual sharp sudden rise and fall. For instance, in the first lead the "R" wave shows a down-stroke and then an up-stroke followed by a down-stroke with a little notch in it. In the second lead it goes up first, then comes down with a notch, and then goes up. In the third lead there is very little departure from the base line. There is an up-stroke, then a down-stroke, then an up-stroke, and the line goes on straight. In normal curves the typical type of "R" wave is first an up-stroke and then a down-stroke, with little interval between the strokes. Here the "R" waves are all abnormal in contour. That represents a type of complex which indicates pretty severe myocardial disturbance. It is the type of change that has been discussed by Dr. Oppenheimer and Dr. Rothschild in the Journal of the American Medical Association August 11, 1917, under the title, "Electrocardiographic Changes Associated with Myocardial Insufficiency, with Especial Reference to Prognosis." It is the type of chronic disturbance in the heart muscle that has a poor prognosis, and, on the whole, that patient as we saw him was the sickest of the group, and in his case there is less probability of much permanent improvement. It is not true, strictly speaking, that he was the sickest looking man, because the next man was probably a little sicker, but the patient that I just referred to is in the hospital for the first

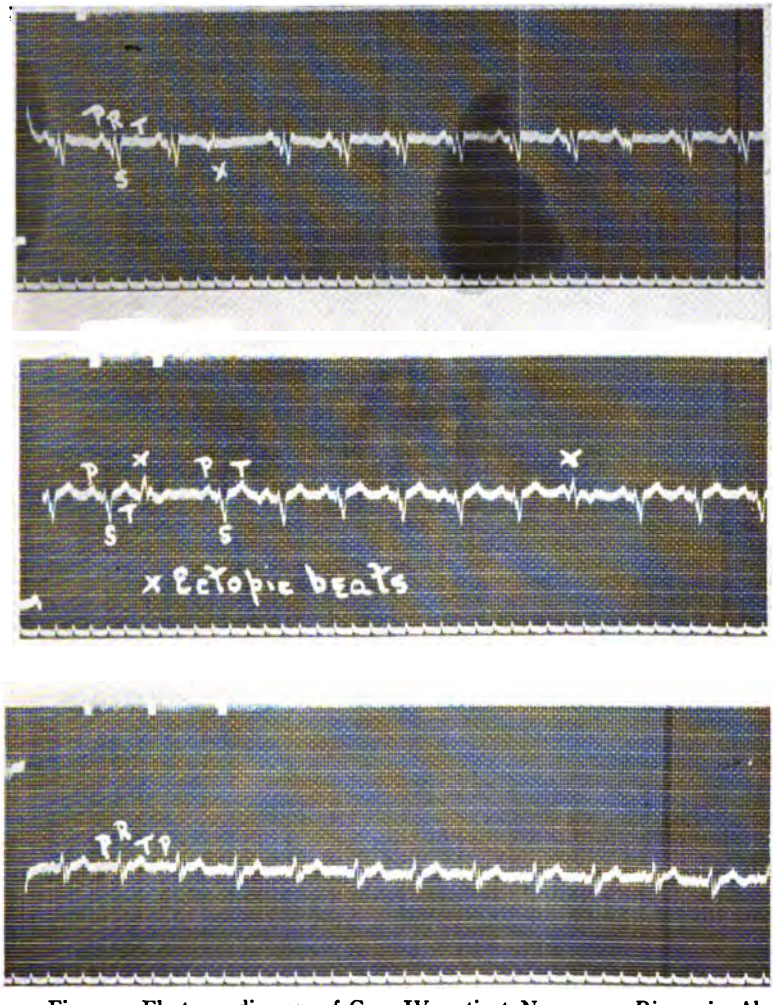

Fig. 91.—Electrocardiogram of Case IV, patient No. 7394. *Diagnosis:* Abnormal form of ventricular complexes; occasional ventricular extrasystoles. *R*, *S*, and *T* indicate ventricular complexes. *P* indicates auricular activity. Note that there is a normal regular relation between auricles and ventricles. At *X* occur ectopic beats. The form of the *R* and *S* waves is abnormal, the line of the wave being thickened and notched, and the interval between its beginning and end being widened, compared with ventricular waves in the electrocardiograms shown in Figs. 88–90.

time, this being his second break in compensation, and the next man is in the hospital for the fifth time, having had about seven

breaks in compensation. In other words, the other man is in pretty bad condition now, but he responded very well to treatment a good many times, whereas this patient will probably not be so satisfactory in that respect.

CASE V

DR. CHRISTIAN: The next patient (P. B. B. H., Med. No. 7282) is sixty years of age. He gives a history of a moderate use of alcohol. However, he worked in a distillery, and the chances are he used more alcohol than two whiskies a day, as given in the history. He did hard labor. He did not sit down and watch the still run. He is a man who did heavy work in the distillery, so there is doubt about his story that he took one or two whiskies a day. He had typhoid in 1911, but no other antecedent diseases. He came to the hospital in July, 1916, with a story that he began to get short of breath fifteen months before that time. Thirteen months before his legs had swelled up. Twelve months before coming he developed nocturnal dyspnea, and that increased so that three months before coming in he started to sleep sitting up in a chair. Three or four months before he came in he had marked swelling of the abdomen. He has been in three or four times since that. He was the man with tortuous, thickened arteries, but not beaded arteries. He had quite marked arteriosclerosis. He was the fellow with the very large heart, going way over into his midaxilla. The feeling was expressed that that heart pretty well filled up that side of the chest, and it was a little hard to distinctly measure its position. Practically no murmur was made out, notwithstanding this very large heart. There was a questionable soft systolic murmur made out at times. As we listened in the clinic we did not hear any murmurs at all. When he came into the hospital this time he had a systolic blood-pressure of 190; diastolic, 130. When he came in his heart was percussed 5 cm. to the right and 20 cm. to the left. His blood-pressure, contrary to the others, has remained high and, in fact, has risen. Here is one reading of $\frac{205}{150}$. No irregularity, I think, was made out. The pulse was regular.

Electrocardiograms (Fig. 92) show a marked left ventricular

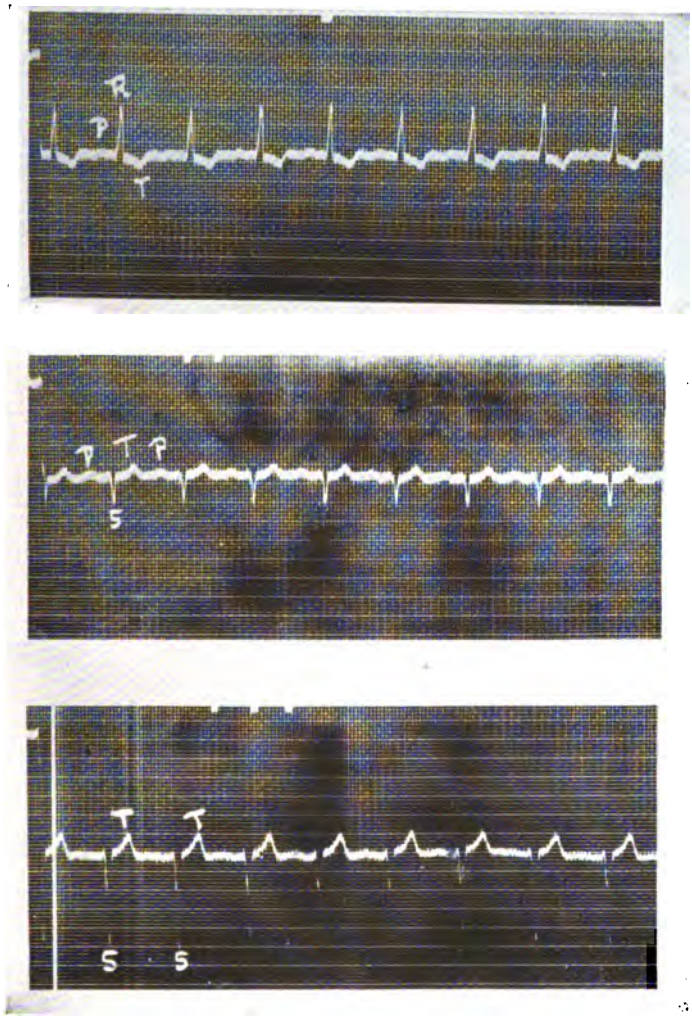

Fig. 92.—Electrocardiogram of Case V, patient No. 7282. *Diagnosis:* Left ventricular hypertrophy. There is a normal relation between the *P* waves, indicating auricular contraction, and the *R* and *S* waves, indicating the beginning of ventricular contraction. The direction of the highest waves in Lead 1 and Lead 3 indicate left ventricular hypertrophy.

preponderance. There are very tall "R" waves in this particular tracing, and a slight irregularity from time to time due to ectopic auricular beats was observed in other electrocardiograms.

The ectopic beats we referred to in previous patients were ventricular in origin. Most of the time the rate is pretty regular.

CASE VII

DR. CHRISTIAN: The sixth patient I will skip over and take up the seventh patient because the sixth patient had a valve lesion, whereas the others did not. The seventh man (P. B. B. H., Med. No. 7407) was fifty-six years of age. He had always been a steady moderate user of alcohol. He had one or two whiskies a day, apparently not more than that, but he kept that up steadily. He did hard, laborious work. He had typical polyarticular rheumatism when sixteen years of age, which was forty years ago. Twelve years ago and three years ago respectively he had the same thing. He came to the hospital for the first time in June, 1916. Three months before that time he began to feel weak, and noticed that his heart pounded. Two months before that he became short of breath. Two weeks before he came in his abdomen became swollen, and three days before coming in his legs became swollen. This is his second admission. Just before he came in this second time he was trying to do light work. Twelve days before he came in he became very short of breath and had palpitation and pain in the abdomen. He had an irregular pulse, a moderate degree of thickening in his radial, and a very considerable degree of thickening in his brachial, artery. He had a loud blowing systolic murmur, at times almost musical. He was fibrillating. Electrocardiograms (Fig. 93) taken in the afternoon show quite marked irregularity, some long pauses, some short pauses—left ventricular hypertrophy and apparently no extrasystole. That case, then, is one of auricular fibrillation. His heart was percussed 3 cm. to the right and 16 cm. to the left. His blood-pressure was slightly up, $\frac{143}{82}$.

CASE VI

DR. CHRISTIAN: The sixth patient (P. B. B. H., Med. No. 7358) was thirty-nine years of age. He had no history of alcohol. He did not do very laborious work, being a cap-maker. There is no history of rheumatism and no history of any acute infec-

tious diseases. Three years before coming to the hospital he had swelling of his hands, feet, and abdomen, apparently an

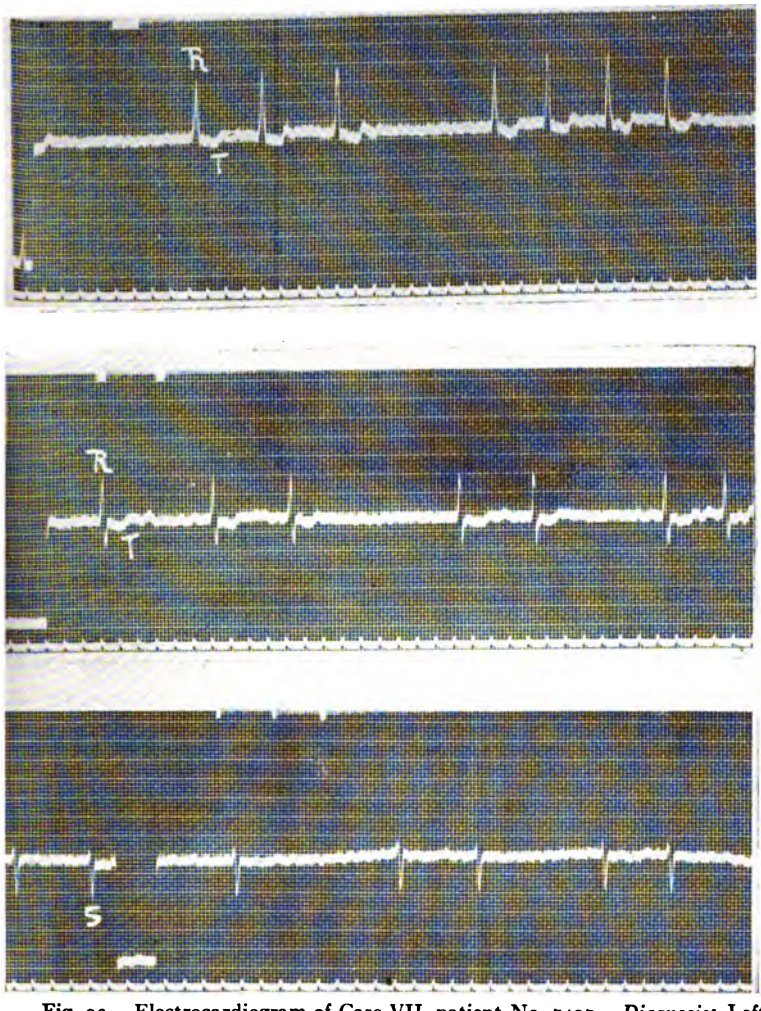

Fig. 93.—Electrocardiogram of Case VII, patient No. 7407. *Diagnosis:* Left ventricular hypertrophy; auricular fibrillation. *R*, *S*, and *T* indicate ventricular activity. *P* waves are absent. In many places the heavy straight line shows slight rapid oscillations, indicating coarser fibrillary contractions of the auricles.

attack of very definite nephritis. About a year before he came in he had a similar attack. His symptoms suggest that he had

a mixture of edema of nephritic origin and edema and shortness of breath of cardiac origin. As we looked him over we found that he had a regular pulse, moderate thickening of the walls, and a very definite presystolic murmur indicating a mitral stenosis. He had a blood-pressure of $\frac{142}{95}$. His heart could not be outlined on account of fluid in his chest obscuring the dulness. The apex was about 14 cm. to the left. He has right-sided preponderance as far as hypertrophy is concerned (Fig. 94); otherwise a normal sequence, regular, no delayed conduction time, and the auricles and ventricles beating in sequence, but a certain tendency toward widening out of his ventricular complexes. It was not marked as in the previous man (Case IV), but rather slower movements of the string than in the preceding case, suggesting a disturbance in the heart muscle.

The point that I wanted to illustrate in these cases is first the varying cardiac symptoms—the different things beginning their symptom complexes—shortness of breath, nocturnal dyspnea, fatigue, pain, edema, etc., as illustrated by these various cases. They also are a group of cases in which, with the exception of one man, there is no evidence of any organic valve lesion. That statement is made, though some of the patients showed no murmur on one extreme, and another patient on the other extreme showed a high-pitched, even musical, harsh systolic murmur at the apex, and the others graded between these extremes, so that there were all sorts of systolic murmurs at the apex as far as localization and quality are concerned, and yet we very strongly feel that none of the patients have a chronic valve lesion. Arteriosclerosis is not a common feature. They illustrate different types of arteriosclerosis and absence of arteriosclerosis, although all have hearts of about the same type. There were beaded arteries, thickened arteries, arteries uniform in diameter, and normal arteries. Arteriosclerosis is not a common feature. Most of them are alcoholic, not all of them. The amount of alcohol varies; some are hard drinkers, some went on sprees, some are moderate continuous drinkers, and some probably used very little alcohol. As I told you before, they all had negative

Wassermann reactions, consequently syphilis did not play any part. All sorts of disturbances in rhythm are illustrated; also

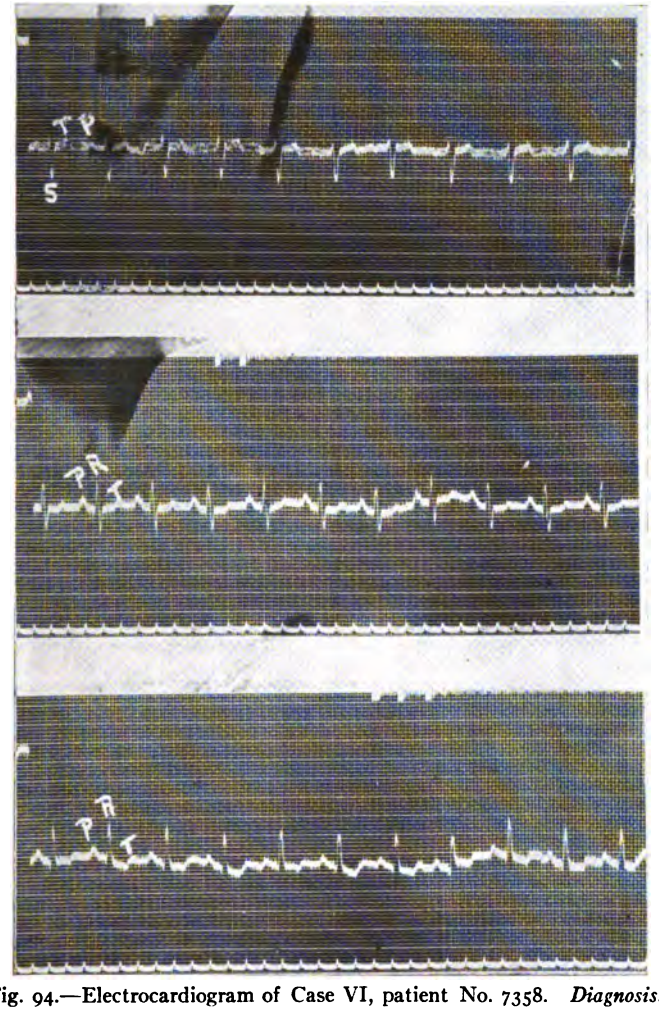

Fig. 94.—Electrocardiogram of Case VI, patient No. 7358. *Diagnosis:* Left ventricular hypertrophy. *P*, *R*, *S*, and *T* waves indicate normal relation between auricles and ventricles. The rate is regular. There is a slight widening in the main curves, *R* and *S* indicating slight myocardial disturbance.

right-sided preponderance, left-sided preponderance, as far as muscle bulk is concerned and an even distribution between the

two sides. That does not mean the heart is not hypertrophied, but means the proportion between the disturbance in the right and left side coincides with the normal ratio as the heart enlarges. Some of them have arhythmias. Some have a regular rate without any disturbance. Some show auricular fibrillation. Some have an irregularity of the extrasystole type; the ectopic beats in one case beginning in the auricles, in two cases beginning in the ventricles. In one in which they began in the ventricles they sometimes began in one place, sometimes in another. Some of them had no disturbance in the electrocardiogram, no disturbance in the rhythm, except muscle preponderance. One of them showed a very distorted type of ventricular complex with a rhythm nearly always regular, occasionally an ectopic beat, but as far as electrocardiograms were concerned showed marked abnormality in the form of the ventricular complex pointing to an extensive muscle disturbance. That was the patient who had quite marked arteriosclerosis and had had two or three severe attacks of pain at night which were interpreted as anginal pain; in other words, coronary arteriosclerosis with rather more signs of organic disturbance in the heart muscle than the other group showed as far as electrocardiograms are concerned.

Then there was the case with all of the manifestations of the other patients as far as weak muscle was concerned, but differing from the others in that he had an organic valve lesion—signs of mitral stenosis. The heart muscle was otherwise in just the same condition as the other group. The reason that I brought him over was because he presents the picture of typical mitral stenosis, but you get no history of any rheumatism, whereas one of the other patients with no signs of a valve lesion had a typical attack of polyarthritis, ordinary articular rheumatism, and one of them had three attacks—one when pretty young and the other two when middle aged, and yet no signs of a valvular lesion. I simply brought those in to contrast them and emphasize the fact that rheumatism may exist and the patient have myocardial disturbance without a valve lesion, but you can find signs of valve lesion without being able to get a history

of rheumatism; in other words, whereas most patients with valvular lesions give a history of rheumatism and most of the cases of myocardial disturbances without valvular lesion do not give a history of rheumastism, there are exceptions. Of course, if you have a patient that suggests a valvular lesion and you do not get a history of rheumatism or infection suggesting rheumatism, that does not justify you in doubting what you hear and what you feel.

Now in regard to these patients from the point of view of what we have done for them and what the results have been. The first patient (P. B. B. H., Med. No. 7377), a fibrillator, came in with a pulse deficit. That is charted on his chart (Fig. 95) by having the apex-rate put down in black circles connected by black lines and the pulse-rate put down in solid black dots connected by black lines. You will remember that the fluid intake and output is represented in the same way. He was given digitalis every two hours for five doses of 0.1 gm. of digitalis. Then he was given 0.1 gm. of digitalis three times a day, and that was powdered leaves, and the leaves grew in Minnesota. (We are using Minnesota digitalis now on the lower floors and Virginia digitalis leaves on the upper floors of the hospital. We are simply trying out some local digitalis, and it is very excellent digitalis. We have used some also from Oregon and some from the State of Washington. It does not seem to make any difference where the digitalis grows in this country, it is really very good digitalis.) As a result of that you will notice that his pulse deficit very largely decreased and he got a diuresis. The urine output jumped from 300 to 1800 c.c. (Fig. 95), and then a few days later went up to 3700 c.c., and in the last day or two it has been about 1500 c.c. on a fluid intake which was restricted to 800 c.c. The patient was on a diet of 800 c.c. of milk, was given digitalis, and the first two nights in the hospital he got morphin sulphate, 15 mgm. the first night and the second night 8 mgm., with 0.5 mgm. of hyoscin; in other words, he got rest in bed, a very restricted diet—800 c.c. of milk—and digitalis, and he has lost over 10 pounds in water as the result of that treatment. He was not weighed the first three days in the hos-

pital. The fourth day in the hospital he weighed 60.7 kilos, and yesterday 55.5 kilos, a loss of approximately 5 kilos, and as there are 2.2 pounds to a kilo, he lost about 11 pounds.

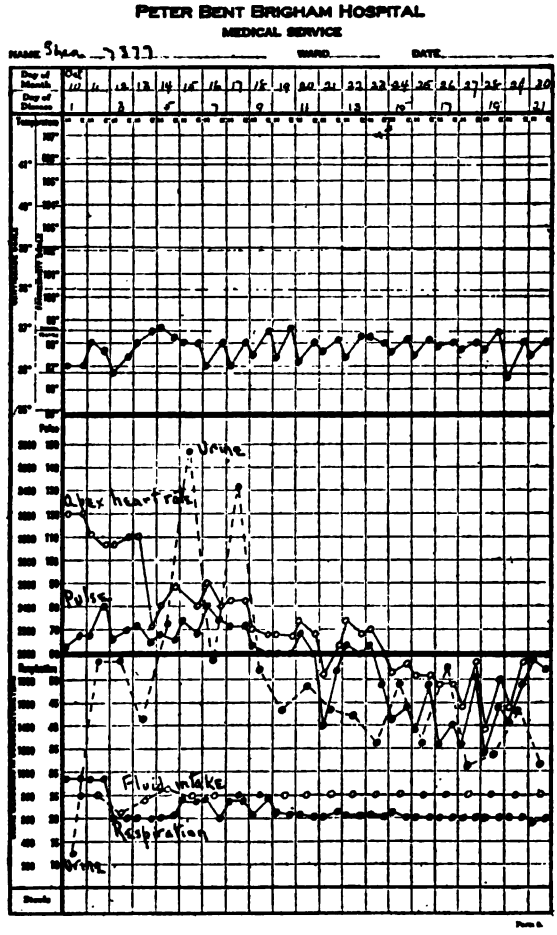

Fig. 95.—Chart of Case 1, patient No. 7377, showing difference between apex heart-rate and radial pulse-rate, so-called pulse deficit. Following the use of digitalis the pulse deficit greatly decreased and there was a marked diuresis.

The next patient's chart (P. B. B. H., Med. No. 7311) (Fig. 96) shows just the same thing. He had a pulse deficit when he first came in with a very rapid radial pulse, and then had a

quieting down of the pulse. His pulse deficit was not so marked when he came in as the other man's. He received digitalis, 0.1 gm. every two hours for six doses, and 0.1 gm. every

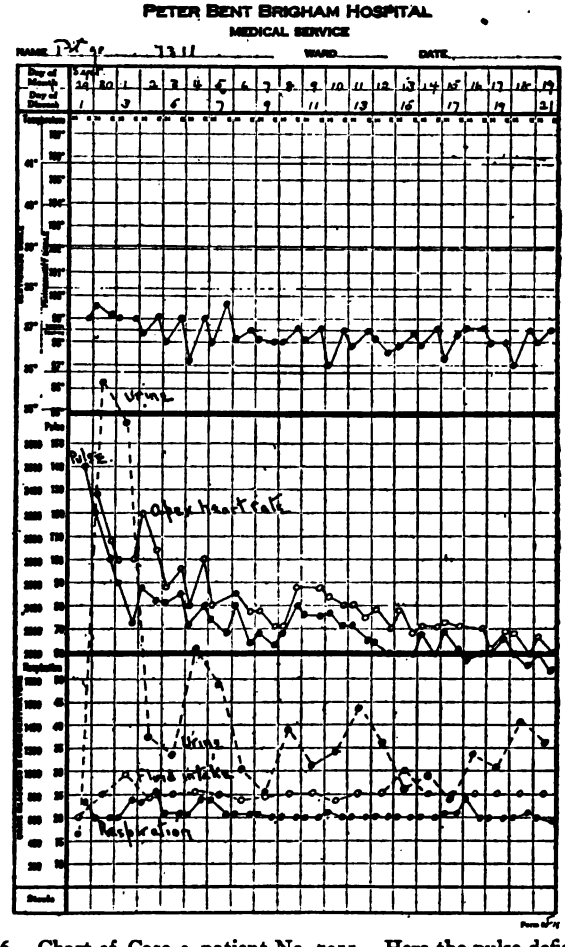

Fig. 96.—Chart of Case 2, patient No. 7311. Here the pulse deficit was less; the radial pulse-rate more rapid. The rate is slowed by digitalis and there is a marked diuresis.

four hours for four doses, then 0.1 gm. three times a day. The first night in the hospital he got codein, 30 mgm., the second night morphin sulphate 15 mgm. One or two nights after that

he was a little restless and got veronal. He was given the same sort of milk diet. After being in the hospital fifteen days he lost 10 kilos, or 22 pounds, in weight, and that was mostly loss of

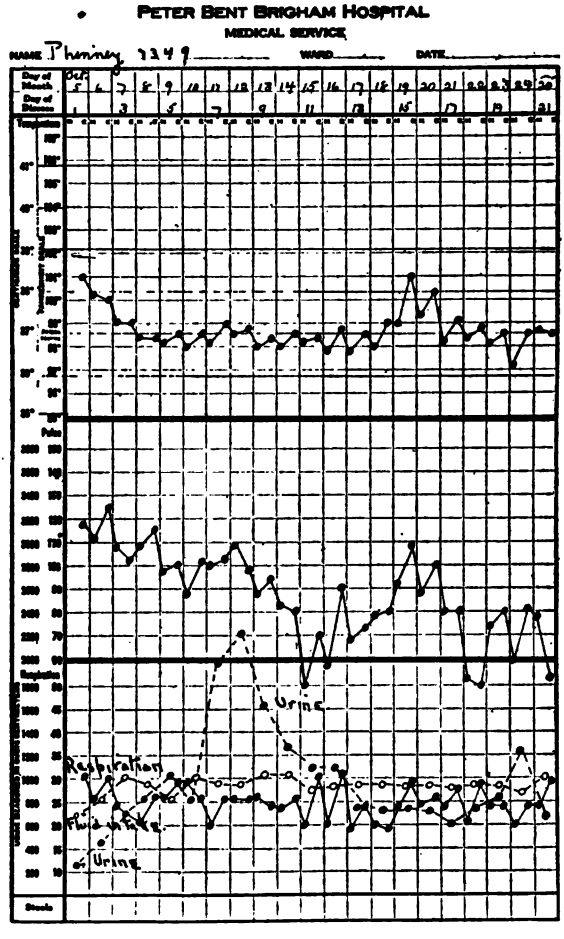

Fig. 97.—Chart of Case 3, patient No. 7349, shows no pulse deficit, but shows slowing of the pulse and a diuresis following digitalis.

water, as he had very active diuresis. Of course there was some loss of flesh on that small amount of milk.

The next patient (P. B. B. H., Med. No. 7349) got digitalis leaves 0.15 gm. every two hours for four doses, and then 0.1 gm.

every four hours for four doses, and that is all he got. He got that in the first two days. That was the patient with extrasystoles. Apparently his extrasystoles seemed to increase and

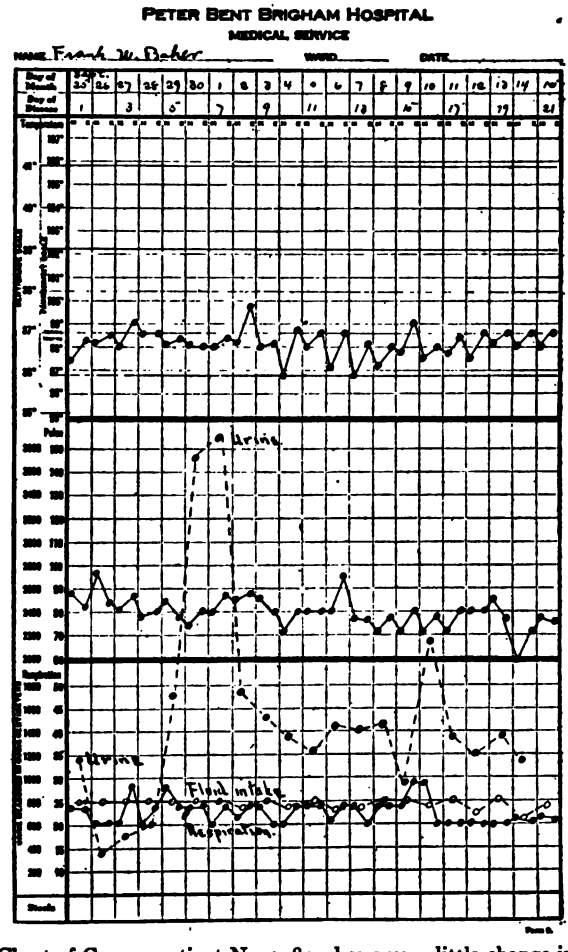

Fig. 98.—Chart of Case 5, patient No. 7282, shows very little change in the pulse-rate, but marked diuresis following digitalis and theocin.

the digitalis was stopped. His pulse is charted (Fig. 97) as 120 when he came in. There was no pulse deficit. It gradually slowed down to about 50. It then increased in rate and he was given some more digitalis. The first night in the hospital he

was given 15 mgm. of morphin sulphate and none subsequently. He did not have very much edema when he first came in, but he lost 7 kilos in weight.

The next patient (P. B. B. H., Med. No. 7394) got a very small amount of digitalis, 0.1 gm. every two hours for four doses. He was given morphin sulphate on two nights, but did not get any more digitalis. He is the patient who had the history of sticking pain in his chest, only moderate edema, and shortness of breath. He essentially got rest in bed for his treatment and only a very small amount of digitalis.

The next patient (P. B. B. H., Med. No. 7282) was started on digitalis about like the other patients. He got diuresis as the other patients have. He got rather a strikingly sharp diuresis, which was added to by using theophyllin or theocin, giving 0.3 gm. and giving three doses. You will notice on this chart (Fig. 98) as it goes around that there is a very considerable diuresis at that point. Before that diuresis he weighed 88.4 kilos, and, as you see, he lost in a short space of time a very considerable amount of fluid. We speak of him as one of our good diuresers. The first time in the hospital on that treatment he lost 39 pounds. The next time he came in he lost 64.6 pounds. He comes in water-logged, and with rest and digitalis, sometimes using a diuretic and sometimes not, he very rapidly floods out his urine. As I said above, that has happened five or six times. He usually gives a pretty prompt response and gets pretty well free from his fluid. The maximum that he has ever lost has been 64.6 pounds and he lost that in ten days, so you see he was pretty busy so far as his kidneys were concerned.

The last patient (P. B. B. H., Med. No. 7407) was treated in just the same way. He was given digitalis leaves, 0.15 gm. at 8 and 10 P. M. This was cut down to 0.1 gm. three times a day, with a gradual decrease in the pulse deficit, marked diuresis, and slowing of the pulse-rate. His weight dropped from 61.4 to 56 kilos in five days.

The case with the valvular lesion (P. B. B. H., Med. No. 7358) was treated just the same way. He had a very considerable diuresis. He was not weighed when he first came in because

he was very dyspneic. He required a good deal of morphin. He is the patient who had a great deal of fluid in his chest. On October 8th he was tapped and 1900 c.c. of fluid was obtained; on the next day 1700 c.c. and on the 13th 1700 c.c., so you see there are 5.3 liters of fluid that were drawn from his chest in three tappings on the 8th, 9th, and 13th respectively. One or two of the other patients, I do not remember just which ones, had fluid in their chests in considerable amount, and that was removed by tapping, so in these cardiac cases if there is a considerable amount of fluid in the chest, so that it seems to be a considerable source of embarrassment, that is removed mechanically. The same thing applies to fluid in the abdomen. We did not tap the patient P. B. B. H., Med. No. 7282, because we were familiar with his habits. We knew that under ordinary circumstances he could get rid of his fluid by action of the digitalis and added to that a diuretic.

What is the etiology in cases of this type? They are almost all alcoholics, but that is probably not the cause of the cardiac lesion. The reason for saying that is we see a lot of these cases that have not been users of alcohol at all, and otherwise they are just the same. Antecedent acute infections probably play a part; some of them undoubtedly. The man with rheumatism probably got his lesion started from rheumatism. Another one had had typhoid fever. That may have played a part, though we do not often see typhoid cause disturbances. Another patient in this group had had pneumonia. We have a case perfectly analogous to this one in the wards now whom I did not bring over because he was so very sick. I did not think it was good judgment to transport him to the clinic and submit him to a certain amount of fatigue when he was so ill. He was in this hospital a year ago with pneumonia. The pneumonia was treated with serum, the temperature promptly fell. His heart was normal in size at that time. His heart was fast when he had fever with the pneumonia, but when he had his crisis it came to normal. We never had any reason to fear the outcome in the case, as we watched him on account of any indications of circulatory embarrassment. That patient has come back in

about a year with a typical story that in the last two or three months he has developed dyspnea; that increased, and he comes in with the picture of a very marked myocarditis, marked cardiac insufficiency, which has not responded to treatment at all. He has been in here for some time and is no better now than when he came in. I do not know that that cardiac lesion is due to pneumonia, but it seems pretty probable that it may be. It just happens that we observed the pneumonia and know that at that time, as far as detected, his heart was normal. We see him again in about twelve months or a little less with a very much enlarged heart, with electrocardiograms indicating this type of thing which we have learned to consider very suggestive of extensive organic disturbance in the heart muscle, so acute infections may play a part, but some of these people did not have acute infections and got the same thing.

Syphilis is so often regarded as the cause of most anything we discuss that it is quite striking that of this group none have syphilis. I did not know that they all had negative Wassermanns until I had them picked out to have sent over, and then found there was not a positive Wassermann in the group. That is in accord with our experience here. Myocardial lesions in the heart as we have seen them less frequently have positive Wassermanns than the average of our patients. The percentage of positive Wassermanns in our chronic myocardial cases is distinctly less than the average of our ward population. That does not say that syphilis does not cause myocardial lesions. It is saying that we see frequently myocardial lesions in which there is no evidence of syphilitic infection. That seems strange if you stop to think that syphilis more commonly than almost any other condition produces vascular lesions. If you go back to your memories of pathologic histology you will recall that characteristic of syphilitic lesions are endarteritis and periarteritis, and you look for extensive vascular lesions as suggesting syphilis. Syphilis is the cause of most aneurysms, another vascular lesion, and yet syphilis does not seem very often to be a cause of chronic myocarditis. We often find in the books just the opposite statement. You find teachers that teach just the

opposite. Dr. Warthin, of Ann Arbor, Michigan, thinks that many myocardial lesions are of syphilitic origin. He has described a good many lesions histologically in the heart as syphilitic lesions. He has stained spirochetes in a good many types of cardiac lesions, but the fact remains that we see many cases of myocarditis in which the Wassermann reaction is negative. It seems to us that syphilis does not play a very large part as a causative factor in these myocardial lesions.

November 6, 1917.

DR. CHRISTIAN: At one of the clinics I showed a group of cases of myocarditis and said that some time I would discuss a little bit more in detail the etiology and the pathology of the lesion in those cases. It is a condition not very well understood from the point of view of etiology. Various things seem to affect the heart muscle and we see a great many cases with these hypertrophied, poorly functioning hearts without valve lesion which at autopsy show really very little that is pathologic in the heart muscle. It has always been a question why that type of heart fails to do its work. It is a big bulk of muscle and often histologically it is pretty normal muscle, and yet clinically we have these marked signs of cardiac inefficiency and symptoms such as shown by that group of patients that I brought into the clinic.

Histologically if you study those hearts, in a certain number you find various kinds of degenerative changes in the heart muscle. Fatty degeneration is fairly common; some of them have hyaline changes in the heart muscle; another group show fragmentation of one kind or another of the fibrils or of the muscle cells themselves. As to that last it is always a question as to how much that is an antemortem and how much it is a postmortem affect and how far it is produced by the technic of hardening and cutting the sections, but some of those cases seem to show very definite destructive changes in the complex fibrils in the heart muscle cells when the fibrils are appropriately stained.

The great trouble in correlating those degenerative changes

with the evident clinical signs of cardiac decompensation lies in the fact that so often at autopsy you get those same kind of changes in patients who during life did not have any evidence of cardiac decompensation. Take, for instance, cases of pernicious anemia. Pernicious anemia usually shows a heart with a marked degree of fatty degeneration, and yet a rather striking feature of pernicious anemia is that cardiac compensation is very good. They may get short of breath with marked anemia, but they do not have signs of cardiac failure, so that these fatty changes can exist without there being much disturbance in the heart muscle function.

In many of these cases we find evidences of circulatory disturbances of the heart muscle; that is, we find changes in the coronaries of a sclerotic type which point to interference with the circulation, but some of those cases, such as the patient with a very large heart whose autopsy material we demonstrated recently, show practically normal coronary vessels—there is no coronary sclerosis. As far as the larger vessels are concerned there is no evidence of poor circulation to the heart muscle.

The question has been discussed a good deal as to whether or not a hypertrophied heart can be a normally functioning heart. That brings up the much discussed question of the athlete's heart; first, as to whether there is any such thing as athlete's heart: and, second, whether an athlete with a hypertrophied heart has not a heart already functionally below par. There is evidence on both sides of the question, both clinical observations and experimental evidence. The fact remains that most hearts larger than normal are hearts not capable of doing the normal amount of work. That is not true of biceps muscle, but seems to be true of cardiac muscle. There may be a circulatory relation there. Cardiac muscle hypertrophies not by a multiplication of muscle fibrils, but by an increase in the size of the individual fibrils. The question has never been very carefully worked out, but the evidence generally goes to show that with the increase in the heart muscle there is not very much of an increase in the capillaries supplying the muscles; or, to put it another way, you have a larger bulk of muscle supplied by pro-

portionately not quite so extensive a capillary system. The enlarged muscle fibrils are surrounded by capillaries, but the functionating part of the muscle substance is further removed from the capillary circulation than occurs when the heart is normal. It would seem probable if under those circumstances the hypertrophied heart muscle, which is continuously working and has only the very briefest period for rest, has less circulation proportionately through it, substances created by the activity of the heart muscle, that is, the waste products, probably would not be removed so rapidly, and in this sense hypertrophy in itself may interfere enough in that broad way with the circulation to make a hypertrophied heart always an inefficient heart, and the simple fact that it has hypertrophied, whatever the cause of the hypertrophy, brings about a deficient cardiac function.

Some of those hearts hypertrophy on account of the inincreased work put upon them by valve lesions, by pericardial adhesions, by peripheral vascular hypertension and causes of that type, and it does not seem so very difficult to understand why these changes might lead first to hypertrophy and then gradual loss of function in the heart muscle. Then there are certain toxic elements that play a part. For instance, the patient who has hyperthyroidism always has an increased heart action as the result of the hyperthyroidism. You are perfectly familiar with the rapid pulse and the palpitation of the heart in the typical case of exophthalmic goiter or hyperthyroidism. Many of those cases, if the hyperthyroidism continues, change their cardiac picture from one of simple tachycardia with possibly slight enlargement to a picture of definite chronic myocarditis with myocardial insufficiency. Very many of the longstanding cases of hyperthyroidism show chronic cardiac failure, so that there we have probably a direct toxic effect on the heart, either as the result of the increased rate and subsequent fatigue or as the result of some direct action on the heart muscle of toxic substances.

Syphilis may explain some of these cases. Syphilis, as I have already said, commonly produces arterial lesions. Syphilis may cause coronary lesions in some of those cases and in that

way lead to damage of the heart muscle. Then the syphilitic lesion itself may produce degenerative changes in the muscle cells, and the degenerated heart muscle cells may be replaced by connective tissue, but then, as I have already said, a very considerable part of these patients with chronic myocarditis have no evidence of syphilis and syphilis cannot be made responsible for the bulk of the cases. It is possible that in a few cases antecedent infectious diseases of one kind or another or simple infections may start a toxic degenerative process in the heart muscle, and that subsequently continue into a chronic myocardial lesion. That apparently is not very frequent because we so often see patients who have gone through pneumonia, typhoid fever, scarlet fever, and infections of that type, and subsequently they have practically no signs of cardiac damage. Occasionally we see patients who following some sort of infectious disease do develop myocarditis such as the patient in the ward to whom I referred as having developed myocarditis within a year following an attack of pneumonia. It is possible there that the pneumonia was the direct cause of the myocardial lesion.

Since the pathologist at autopsy so often can find no lesion to explain why the heart is enlarged, why the heart has failed, various men have tackled the problem from different points of view and made an effort to explain how slight lesions found in the heart muscle conceivably might cause the deficient function. One of the early workers in that field was Krehl, who was at that time in Leipzig, and the work is ordinarily spoken of as the work of the Leipzig School. Krehl and a group of his associates in the Department of Medicine there (Krehl was an internist, not a pathologist) studied large numbers of hearts by taking blocks of tissue systematically from different portions and sectioning them, and found very commonly in those hearts whereas there was not much connective-tissue increase in many of the blocks, yet if the heart muscle was studied *in extenso* you found numerous areas of connective-tissue increase, and he rather thought that the bulk of that process represented enough mechanical interference with the action of the heart muscle by

the connective tissue to explain fairly well the hypertrophy and the subsequent failure of function. Occasionally we see patients in which there is no question but that a chronic diffuse interstitial myocarditis with connective-tissue increase all over the heart muscle is directly responsible for the inefficiency of the heart muscle, but those cases are not very common. At autopsy every now and then we see one of that type. The characteristic thing is that usually there is relatively little connective-tissue increase and that is focal in its distribution.

Krehl and some of his associates had the idea that probably masses of connective tissue not very large in themselves might be situated in certain regions so that they would definitely interfere with the heart function, and that group of men rather worked out the idea that the muscle groups that controlled the heart valves, in part the sphincters, in part the groups of muscle masses to which the chorda tendineæ are attached, might have a more definite function than we ordinarily think of, and slight damage in these particular places might interfere enough with the function to give you regurgitation, and subsequent to the regurgitation back-pressure and a train of disturbances more or less mechanical after they were started. That was the general viewpoint of Krehl and the Leipzig School, that the thing could be explained on the basis of small areas of connective tissue interfering in some way with the function of the heart. That idea was elaborated a little bit more by a man named Albrecht, who published a very extensive monograph on the heart muscle (Der Herzmuskel und seine Bedeutung f. Physiologie, Pathologie und Klinik des Herzens, Berlin, 1903), which I will pass around, and which boils down to the viewpoint that the heart muscle should be regarded in the same light as any other muscle in the body; namely, a complex structure with muscle bands or muscles with tendons that had definite points of insertion and definite points of origin, and that the ventricles, for example, were not simply masses of muscle without any particular structure, but highly organized muscle in the sense of muscle groups whose function depended upon a particular interrelation and correlation as they contracted and as they relaxed, and in that

sense slight disturbance placed at certain points, which might easily escape detection unless very careful study was made of the entire heart muscle, might be responsible for very extensive disturbance in the function of the heart. Of course there is a certain amount of reasonableness in that viewpoint, but it has not been very generally accepted and not very many people have agreed with Albrecht in that view.

When Aschoff and Tawara took up the study of the conduction system of the heart and found out how extensive it was, they made an attempt to explain the lack of function on the basis of the distribution of small degenerative processes in the conduction system at different points, explaining the poor function by the interference with the arrival of stimuli, so that they arrived at different parts of the heart at different times; on this account instead of getting perfectly simultaneous stimulation at all parts of the ventricles you get an irregular stimulation and irregular contraction response. Obviously if that happens it considerably interferes with the function. They brought together their views in the study of a certain number of cases in this little monograph which was published in 1906 (Aschoff and Tawara, Die heutige Lehre von den pathologischanatomischen Grundlagen der Herzschwäche, Jena, 1906). It is of interest that what I referred to in regard to the electrocardiographic disturbances that were emphasized recently by Oppenheimer and Rothschild—abnormal ventricular complexes somewhat suggesting a degenerative condition in the right or left branch of the bundle of His—probably do point to an interference with the peripheral distribution of the conduction system, and they found in a considerable number of cases which they studied areas of connective tissue increase along the intraventricular septum, etc., fitting in with the theory of Aschoff and Tawara and the electrocardiographic disturbance pointed to that change. This very recent work with the electrocardiograph rather definitely favors the view of Aschoff and Tawara that the association of the lesions with the conduction system may explain how rather trivial lesions, trivial in the sense of their size as made out by histologic examination, may cause very marked disturbances in the cardiac

mechanism. However, it is to be remembered that only relatively few cases of myocarditis show these abnormal ventricular complexes. It is not at all improbable that all of these factors may play a part.

The point remains that there is a definite form of cardiac decompensation in which there is no valvular lesion and which at autopsy shows precious little pathologic disturbance. During life we call those cases of chronic myocarditis. We have long since learned that that term does not mean that at death we are going to find an extensive interstitial myocardial lesion; sometimes the pathologist will find a lesion, very often he will find none at all, and in that sense it is not a very good name for the condition. It has been in use for a long time, and is, on the whole, about as good as any of the other names suggested, so we have continued to use the term in that sense referring to that particular type of case, realizing that the pathologic diagnosis very often will not conform to that diagnosis, that the pathologist uses myocarditis in the sense of an inflammatory process—a chronic inflammatory process—and that he may or may not find connective-tissue increase, and in the latter event he will not call it chronic myocarditis, and yet during life there has been a chronic disturbance in the function of the heart muscle rather than in the valves or in the peripheral channels. Some of the cases have hypertension and some of them do not.

CLINIC OF DR. ELLIOTT P. JOSLIN

NEW ENGLAND DEACONESS HOSPITAL

TWO CASES OF SEVERE DIABETES[1]

ALTHOUGH you are about to commence practice with a clean slate and a mortality of zero, I venture the prediction that you are destined to spend many anxious hours and many sad ones, too, in an effort to combat the disease which is to claim our attention this afternoon, and the complication which gives to it its chief terror. The increasing prevalence of diabetes you will appreciate when I tell you that it is recognized four times as frequently in Boston today as in 1890, and twice as frequently throughout the registration area of the United States as in 1900. And as for the importance of diabetic coma as the chief complication, my own statistics are a mute but faithful witness. Thus, up to December 1, 1916, 60 per cent. of all my fatal cases of diabetes died of diabetic coma and coma was responsible for 82 per cent. of the mortality of all those cases who succumbed during their first year of the disease, and of all the fatal cases in children save one.

Coma is a complication which is almost always preventable. It occurs in severe diabetes; however, it may develop in a diabetic whose diabetes is of moderate severity, though made artificially severe by accident or improper medical treatment. Most of those cases who die of coma during the first year of the disease undoubtedly belong to this group, and, I regret to say, some of them were under my own care. The distinction between severe diabetes and diabetes accompanied by acidosis should be emphasized. By severe diabetes is generally understood that

[1] The two clinics upon which the data here given are based and at which the patients here described were shown were held at the Peter Bent Brigham Hospital at the invitation of Professor Henry A. Christian in December, 1917.

type of the disease in which the patient excretes sugar in the urine when on an exclusive protein-fat diet, plus, at the most, 10 grams of carbohydrate in the form of green vegetables. The presence of severe diabetes by no means implies the simultaneous presence of acidosis. The 2 cases of diabetes which I shall show you this afternoon showed acidosis at entrance, but before discharge this had disappeared, and yet the diabetes remained severe. As a matter of fact, no cases under my care have ever come so near diabetic coma and then recovered as these. They illustrate well what I have already said, for though the complication has been overcome, the disease in all its severity remains. The ability to make this distinction constitutes a great advance in our diabetic knowledge. But increased knowledge means added responsibility, and I believe one can usually say with truth that for each death by diabetic coma there is some one who should bear the responsibility.

You may well be dismayed, for I have told you that nearly two-thirds of all diabetic patients have succumbed to coma, and in the next breath assert that generally some one is to blame. While this is the case, because before the law there is no excuse for ignorance, on the other hand, some other facts which I will present to you are reassuring. For this reason I will summarize the experience of the Massachusetts General Hospital for a long series of years, as well as my own recent results with private patients at the Corey Hill and New England Deaconess Hospitals, and you will see that the results of treatment are very different now from what they were even a decade ago.

TABLE I

THE RECENT IMPROVEMENT IN DIABETES AS SHOWN BY THE STATISTICS OF THE MASSACHUSETTS GENERAL HOSPITAL

Period.	No. of cases.	Mortality during hospital stay. No. of deaths.	Percentage.
1824–1898	172	47	27
1898–1914	284	80	28
1914	51	8	16
1915	89	11	12
1916	103	8	8
1917	105	6	6

TABLE II

CASES OF DIABETES TREATED AT THE COREY HILL AND NEW ENGLAND DEACONESS HOSPITALS BY E. P. J.

Year.	No. of cases.	Mortality during hospital stay. No. of deaths.	Percentage.
1913	43	4	9
1914	60	3	5
1915	109	6	6
1916	164	8	5
1917	181	4	2

No one inspecting these two tables can fail to see the improvement which has taken place in treatment. The type of patient has not essentially changed, but the character of the treatment has greatly altered, and for the better. And although one cannot say that all of the deaths at the Massachusetts General Hospital were due to coma, most of them were, and the evidence which such a group of statistics furnishes indicates that coma must have become less frequent, and that acidosis, the forerunner of coma, has been better treated. However, I feel confident in assuring you that the end of progress along this line has by no means been reached. Even adopting the same plan of treatment as that which I shall describe to you today, I believe that 3 of the 4 deaths from coma during 1917 in my own hospital series would be avoidable, and I am convinced that it would avail even if applied to patients in a condition still more desperate.

Before asking the patients to come in, may I say a few words about the etiology, diagnosis, and treatment of this condition?

The *cause* of the coma of diabetic patients is due to acid poisoning (acidosis), or now perhaps better and more commonly expressed, to the diminished alkaline reserve of the body. Acidosis can occur in health if the carbohydrate in the diet is excluded, and it will become severe when, along with protein, fat is taken in excess. In diabetes it may also develop under similar conditions when carbohydrate is excluded from the diet, but it will also appear when carbohydrate is taken but not assimilated. In other words, acidosis will appear when the body does not have carbohydrate to burn or suddenly loses the ability to burn it.

Unfortunately, the *symptoms* of the patient do not always suggest the severity of the condition. Even nurses and doctors

who have seen many patients go into coma occasionally overlook the imminence of its onset. Restlessness, weariness, extreme languor, and various forms of indigestion often precede its full development, and, like the crowning symptom of exaggerated breathing (hyperpnea), may pass almost unnoticed. Therefore, I caution you always to see your severe cases frequently, and to be on the watch for anything in symptoms which differs from the usual in the patient's condition. The laboratory helps us out, and by examination of the urine, blood, and respiration a knowledge of the actual condition can be obtained. It is true that analyses of the blood furnish us with the most direct data, and next to these come the tests of the expired air, but even if these rather more complicated methods are not at your disposal, the simple reaction for diacetic acid, made with the aqueous solution of ferric chlorid, will seldom play you false. So far as I am aware none of my diabetic patients have ever developed diabetic coma who did not show a positive reaction for diacetic acid in the urine, and this is the important point. It is true that during diabetic coma this reaction in very, very rare instances disappears, but I remember to have seen this only at such a stage of the coma that the patient was beyond help. I wish to emphasize this point, because no one should endeavor to escape the responsibility for a death from diabetic coma because he is without the modern appliances for the examination of the blood and breath.

The *treatment* of diabetic coma which I employed for about fifteen years was based upon the principle that alkalis were needed to combat the acidosis and, therefore, should be used in large quantities. For this reason I gave enormous doses of alkali—not uncommonly over 100 grams in twenty-four hours. My results were unsatisfactory, and though the alkalis cannot be blamed by any means entirely for the multitude of deaths from diabetic coma which I encountered, yet I believe they played an important part in preventing recovery—indirectly it is true—through the nausea and vomiting which they provoked and the consequent inability of patients to take food or drink. At any rate, during the last few years I have felt far better satisfied with my results from treatment without alkalis, and until re-

turns from other methods of treatment show more success I commend my course to you. I do this notwithstanding the fact that in November you were advised by an eminent authority to give 5 grams of sodium bicarbonate in 100 c.c. of water by mouth every hour, with the suggestion that in case the bicarbonate were not retained, 250 c.c. of a 3 per cent. solution of sodium bicarbonate should be administered intravenously at intervals of three or four hours. I realize that you are in somewhat of a quandary, for "When doctors disagree—," but may I point out that in the one case the treatment was advised, but the results of treatment were not given, whereas I shall report to you the results of treatment and leave the decision to you as to whether to adopt it. But, again, may I emphasize how sorry I should feel if you should infer from anything I have said that I consider present methods satisfactory. They are not. Perhaps most of all they are valuable because they establish a basis on which the usefulness of other methods of treatment may be tested. Just as soon as I find a series of cases of diabetes of greater severity successfully treated in any other manner I shall be only too glad to adopt the procedure. It is for this reason that I have recorded data in Table III regarding 15 of my cases who have been threatened with diabetic coma and left the hospital alive. For your encouragement and mine I would point out that 7 of this series replace 7 cases less severe in a similar table published only six months ago.

Presentation of First Case.—The younger of these two patients I now show you, Case No. 1012, gave a history of polyuria and weariness in January, 1915, at the age of thirteen years, and in the following month the urine was of 1035 specific gravity, contained 5.1 per cent. of sugar, and the acetone and diacetic acid reactions were triple positive (+++). The etiology remains obscure, for obesity, heredity, and a history of recent infections were wanting. At onset the patient weighed 64 pounds, but, as not unusually happens following the discovery of the disease and adjustment of diet, the weight increased 11 pounds in the next seven months—a gain in weight which most clinicians have recently come to regard as inconsistent with safety during

TABLE III

SUCCESSFUL TREATMENT WITHOUT ALKALIS OF 15 CASES OF DIABETES THREATENED WITH COMA

Case No.	Date.	FeCl.	NH_3.	Blood, CO_2 mm. Hg.	Alveolar air, CO_2 mm. Hg.
691	Nov. 15, 1917	+	..	..	20
1200	May 29, 1917	+++	2.3	..	18
786	June 11, 1916	++	3.9	..	18/20
	12,	+	3.2	24	21
765	Dec. 6, 1915	+++	3.3	..	21
	Jan. 24, 1916	++++	2.6	..	21
942	July 12, 1916	+++	4.4	20	20
	13,	++	3.7	..	17
938	Nov. 2, 1917	++++	1.3	..	18
1303	May 30, 1917	++	2.1	..	21
1273	March 30, 1917	++	..	..	22
755	April 15, 1917	+	1.6	..	18
1011	March 29, 1916	++	1.8	..	23
	April 13,	++	..	..	22/22
	Sept. 25, 1917	++++	..	..	15
1085	Oct. 30, 1916	?	1.7	28	20
1196	Dec. 8, 1916	++++	4.6	..	21
	9,	++	6.0	26	22/14
	10,	+++	3.3	..	18/20
	11,	+	3.1	26	20
	12,	++	3.3	..	21
	13,	++	2.9	..	24
1070	June 23, 1916	++	1.9	21	20
1012	Sept. 13, 1917	+++	..	..	14
	14,	+++	2.5	21.3	14
	15,	++	2.3	..	16
1120	Sept. 6, 1916	+++	..	..	21
	7,	+	..	..	18
	Oct. 11,	++	1.9	..	22
	14,	o	..	..	20
	27,	+	..	..	15

the first year of treatment of the young diabetic. In March, 1916, the patient first came under my observation. Physical examination was negative, save for emaciation and weakness—untoward signs in a child—weight 68 pounds (31 kilograms), height 4 feet 6½ inches. (Today, December 31, 1917, the weight of the patient has decreased 10 pounds, but the height has advanced 3 inches.) An acetone odor to the breath was absent despite the quadruple plus (++++) ferric chlorid reaction in the urine for diacetic acid.

The patient was placed upon a diet containing

	Carbohydrate, grams.	Protein, grams.	Fat, grams.
5 per cent. vegetables (300 grams).....	10	5	0
Small oranges (2).....	20	0	0

for the balance of her first day in the hospital, as well as the succeeding day, but upon the following day the oranges were omitted. Fasting, save for washed vegetables, was carried out the next twenty-four hours and complete fasting for the day following, with the result that the urine became sugar free and the diacetic acid reaction fell to one plus (+). That the acidosis still was important is shown by the 2 grams of ammonia which the urine contained on this day instead of a normal of 0.5 to 1 gram, and this was also confirmed by a lowering of the carbon dioxid tension of the alveolar air from its normal at 40 in terms of mm. Hg. to 29. The significance of these modes of expression of the acidosis has been explained in previous clinics by Dr. Palmer and Dr. Geyelin. I will simply point out here that urinary ammonia values above a gram represent an increase, and that this is nature's method of furnishing an alkali to counteract acidosis. A lowering of the CO_2 in the alveolar air implies a similar lowering of the CO_2 tension in the blood, and is due to the replacement of the normal but weak carbonic acid by the abnormal but strong beta-hydroxybutyric acid and its derivatives.

The day of the washed vegetables upon which the urine became sugar free was followed by a day of complete fasting, and that by a day in which the diet contained 5 per cent. vegetables, 150 grams—the equivalent of 5 grams of carbohydrate and three of protein. (The average of the vegetables in the 5 per cent. group do not show over 3 per cent. carbohydrate, especially after they have been cooked, and I therefore, as a rule of thumb, consider that each 30 grams (1 ounce) of 5 per cent. vegetables contain 1 gram of carbohydrate and ½ gram of protein.) This addition of carbohydrate to the diet brought no return of sugar, and while upon it the diacetic acid reaction disappeared and did not recur up to the time of the discharge of the patient from the hospital May 22, 1915. During this first hospital stay the carbohydrate in the diet was gradually increased to 20 grams, later simultaneously the protein and fat, and glycosuria did not occur for over two weeks, at which time the food amounted to carbohydrate 21 grams, protein 43 grams, fat 40 grams; calories

per kilogram body weight 20. The blood-sugar at this time was 0.21 per cent., unfortunately nearly twice the normal.

The rapid disappearance of the diacetic acid reaction and the return of the CO_2 tension of the alveolar air to normal (38 mm. Hg.) in this case in contrast to the persistence of such reactions in cases apparently not so severe, but under treatment with large doses of sodium bicarbonate, is to me striking and significant. For example, Case No. 344 of my series showed 2.6 grams of ammonia in the urine on June 29, 1910, and from that date until February 26, 1912, constantly was under alkaline treatment. At no time did the urine fail to show a diacetic acid reaction, although sodium bicarbonate, usually 20 grams or more, was ingested daily. Contrast Case No. 344, unsuccessfully taking 6 teaspoonfuls of soda for a period of twenty months, with this little child, achieving freedom from acidosis without any alkali in half as many days. Surely clinicians will hesitate long before adopting the advice of the laboratory expert "that the therapeutic use of soda should be one of the most frequent prescriptions of the physician."

It would be unfair, however, to imply that the only difference in the treatment of acidosis between Case No. 344 and our present patient consisted in the administration of the alkalis to the one and the withholding of the same from the other. There were, in fact, two other radical differences: the first relates to the rôle played by fat in the diet, and the second to fasting—each of fundamental importance in the treatment of acidosis and about each of which little was known in 1912—mark you, only five years ago. In this patient's present chart (Table IV) you may have noted that all fat was withheld from the diet until for some time after she had become sugar and acid free. This is perhaps the crux of the situation, for in the fat of the diet or of the tissues acidosis finds its origin, and it matters little whether the subject is diabetic or not, provided he is either, like the diabetic, unable to assimilate carbohydrate, or in the case of a normal individual, deprived of it. As you will remember, Folin and Denis have beautifully shown that in the first fast of an obese, but otherwise healthy individual, acidosis occurs, though they also showed

TABLE IV

CHART OF CASE NO. 1012

Date.	Diacetic acid.	Ammonia, total gm.	Sugar in urine, gm.	Diet in grams.					Carbohydrate balance, gm.	Weight, kg.	Blood-sugar, per cent.	Alveolar air, CO_2 mm. Hg.
				Carbohydrate.	Protein.	Fat.	Alcohol.	Calories.				
1917												
Sept. 13	+++	0.2	(3.3%)							26		14
" 13–14	+++	2.5	30	20	17	0	0	148	−10		0.36	14
" 14–15	++	2.3	34	15	3	0	0	72	−19			16
" 15–16	+		22	10	3	0	0	52	−12	26		16
" 16–17	++		18	0	0	0	0	0	−18			20
" 17–18	+		19	0	0	0	0	0	−19			29
" 18–19	sl. +		25	5	24	0	0	128	−20			23
" 19–20	sl. +		13	5	24	0	0	128	− 8	27		19
" 20–21	+		22	5	24	0	0	128	−17			19
" 21–22	sl. +		11	0	0	0	0	0	−11			
" 22–23	sl. +		4	3	18	0	8	140	− 1	28		19
" 23–24	+		11	0	0	0	15	105	−11			23
" 24–25	+	2.6	21	0	24	0	15	201	−21	29		19
" 25–26	0		10	0	0	0	15	105	−10		0.31	21
" 26–27	sl. +		0	0	0	0	15	105	0			23
" 27–28	0		0	0	0	0	15	105	0			23
" 28–29	0		5	0	24	12	15	319	− 5	30		22
" 29–30	0		5	0	24	24	15	417	− 5	31		28
Oct.												
" 30– 1	0		9	0	24	24	15	417	− 9	32		26
Oct. 1– 2	0		8	0	24	24	20	452	− 8	33		30
" 2– 3	0		0	0	0	0	0	140	0		0.26	27
" 3– 4	0		3	0	24	24	20	452	− 3	32		
" 4– 5	0		5	0	24	24	20	452	− 5			
" 5– 6	0		9	0	36	32	20	572	− 9			
" 6– 7	0		10	0	36	40	20	644	−10			31
" 7– 8	0		12	0	36	40	20	644	−12			
" 8– 9	0		4	0	0	0	20	140	− 4			28
" 9–10	0		0	0	6	6	15	183	0	30		
" 10–11	0		0	0	12	12	15	261	. 0		0.24	

that this appeared less severe during subsequent fasting periods. The lesson of our case and that of other similar cases has so strongly impressed itself upon me that it has led me to suggest the following preparatory treatment for fasting in all cases of diabetes with acidosis and in some other groups as well, when an acidosis if it did develop might become serious because of cardiorenal complications:

In severe, long-standing, complicated, obese, and elderly cases, as well as in all cases with acidosis, or in any case if desired, without otherwise changing habits or diet, omit fat; after two days omit

protein, and then halve the carbohydrates daily until the patient is taking only 10 grams; then fast. In other cases begin fasting at once.

Fasting during two days was the second element in addition to the omission of fat, which hastened the rapid disappearance of the acidosis in our little patient. Allen has clearly pointed out that fasting usually leads to the disappearance of acidosis in the diabetic, though occasionally, as Stillman, working with him, has shown, this does not occur.

The patient left the hospital on May 22, 1916, free from acidosis and sugar, with a blood-sugar of 0.13 per cent. and a diet containing 34 grams of carbohydrate, 72 of protein, and 113 of fat, 1441 calories. She weighed 67 pounds (30.5 kilograms). Today, nearly two years later, I feel I made a mistake in allowing so large a diet, for you will note that the patient was receiving approximately 50 calories per kilo, whereas undoubtedly 40 calories or even less would have sufficed, and, as I hinted above, would have been far safer.

I am partly led to this opinion because on December 22d the patient returned to the hospital weighing 69 pounds (32 kilograms)—a gain of 2 pounds since her discharge in May (Table V). At this time there was but 0.1 per cent. of sugar in the urine, but the blood-sugar was 0.27 per cent., the reaction for diacetic acid in the urine showed only a trace, and the CO_2 tension of the alveolar air was 31 mm. Hg. During the first day in the hospital she received 5 per cent. vegetables 300 grams, equivalent to 10 grams of carbohydrate and 5 grams protein, but no other protein and no fat, and with this the diacetic acid disappeared, not to return during her stay, which ended January 8, 1917. Upon the above diet the sugar promptly fell to a trace and disappeared entirely the following day. The diet was gradually increased, but the patient did not tolerate more than 15 grams of carbohydrate, 32 grams of protein, and 23 grams of fat, amounting to 14 calories per kilogram of body weight. Even upon this meager ration I am sorry to add that the blood sugar, which had fallen in the early days of treatment to 0.16 per cent., rose to 0.24 per cent. when she left, at which time she was taking 10 grams of carbo-

hydrate, 33 grams of protein, and 35 grams of fat, the equivalent of 17 calories for each kilogram of her body weight. Note the contrast with the diet at her discharge from the hospital on her first visit, when the calories were 50 per kilo body weight.

The third entrance of this patient to the hospital was on September 13, 1917. (See Tables IV and V.) Her condition was then far more precarious. The weight was 58 pounds (26 kilograms), blood-sugar 0.36 per cent., Wishart acetone test quadruple positive (++++), and in the urine the sugar amounted to 3.3 per cent., the reaction for diacetic acid was triple positive (+++), the ammonia 2.5 grams in twenty-four hours, the CO_2 tension of the alveolar air in terms of mm. Hg. pressure was 14, the lowest reading with discharge of the patient from the hospital alive in my personal experience, though Dr. Geyelin has shown recovery, also without alkalis, to be possible even under more adverse conditions. Two days later the CO_2 in the blood was equivalent to 21.3 mm. Hg. The breathing at entrance was distinctly labored—the hyperpnea characteristic of diabetic coma. Fortified by the experience with this patient at the time of her first entrance when she also showed acidosis, as well as by results with other patients, I adopted the same plan of treatment as before, namely, the omission of fat and the feeding of a small quantity of carbohydrate followed by fasting. The details are shown in Chart IV. This time, however, the acidosis was more severe, and despite three days of feeding and two days of fasting, both acidosis and sugar remained present in the urine. The patient, therefore, was fed for the three subsequent days on 5 grams of carbohydrate and 27 grams of protein—the approximate amount contained in 150 grams of 5 per cent. vegetables and 120 grams of fish; but even on the third day of this limited diet the sugar amounted to 22 grams in the urine and the diacetic acid was still present. Indeed, it required a day of fasting, a similar day of restricted diet, followed by four alternate days of feeding and fasting, and then three days of complete fasting, save for 15 grams alcohol, until the acid disappeared and the sugar was reduced to a trace. With this general plan of treatment the urine became entirely free from sugar on

TABLE V

CASE NO. 1012

No. of visit.	Date.	Length of stay (weeks).	Condition at entrance.					Condition at discharge.				
			Urine.		Blood-sugar, per cent.	Alveolar air, CO_2 mm. Hg.	Wt., kilos.	Urine.		Blood-sugar, per cent.	Alveolar air, CO_2 mm. Hg.	Wt., kilos.
			Diacetic acid.	Sugar, per cent.				Diacetic acid.	Sugar, per cent.			
First	March 13, 1916	10	++++	4.4	0.36	34	31	0	0	0.13	34[1]	31
Second	Dec. 22, 1916	2½	+	0.1	0.27	31	30	0	0	0.24		29
Third	Sept. 13, 1917		+++	3.3	0.36	14	27	0	trace	0.29	37	26

[1] Two weeks before discharge.

October 11th—twenty-nine days after entrance. However, these persistent efforts were rewarded, because from November 8, 1917, until the discharge of the patient, December 31, 1917, sugar occurred only on two days, and then was only a trace, the diacetic acid was invariably absent, and the CO_2 tension in the alveolar air was 37 on discharge. In other words, she is a severe case of diabetes, but without acidosis. The blood-sugar, which had remained persistently high, gradually fell to 0.18 per cent. on December 20, 1917. The diet upon which the patient now lives consists of 3 grams of carbohydrate, 55 grams of protein, 40 grams of fat, and 5 grams of alcohol, making 627 calories, amounting to 24 calories per kilogram body weight. The patient will be discharged with this régime and instructed to stay upon it, with a fasting day each week. She is not to increase it unless the blood-sugar falls to normal. Should sugar appear, fasting is to be followed for a day, and for the subsequent two weeks thrice washed vegetables are to replace the 3 grams of carbohydrate which she now receives.

Other features of this case to which I would call your attention are the gradual return of the alveolar air to a normal figure of 36 on November 6th, and 37 on December 31st. For three weeks the alveolar air remained in the neighborhood of 32 and 33. In a debiliated individual, however, it is not uncommon to find the alveolar air somewhat reduced.

TABLE VI

THE OMINOUS INCREASE OF THE BLOOD-FAT OF CASE NO. 1012 DESPITE HOSPITAL TREATMENT

Date. 1917	Blood-fat (per cent.) (Bloor).
November 7	0.69
November 20	0.88
December 5	1.03
December 13	1.25
December 20	0.998
" 27	0.817
" 30	0.895

The *blood-fat* (Bloor's fat) on October 15th was 0.823, in contrast to 0.60, which would be a normal value. On November

7th it was 0.69. On November 20th, when the patient's diet had been only increased in a limited way, the blood-fat had risen to 0.88. On December 5th an increase up to 1.03 was noted, and by December 13th this had risen again to 1.25—unwelcome evidence, I must confess, of a pathologic condition which at present is difficult to combat. Subsequent values were lower. (See Table VI.)

Always court graphic demonstration of failures quite as much as of successes in treatment. The unvarnished truth is always helpful. By thus calling your attention to these figures I fully expect that some one of you in years to come will help to improve upon them. I wish that one could say of the blood-fat as it is possible to say of the blood-sugar in an elderly diabetic, that such an increase is borne apparently without harm to the individual, but I cannot even take this comfort, and must acknowledge that this is the most ominous sign which now confronts this patient. However, we are in the early days of our knowledge of blood-fat, and we must not be discouraged. It is a great gain to have discovered the enemy, and we can find some solace in the thought that this patient is traveling in a region into which none under our care have hitherto penetrated.

How recent is our knowledge of the blood lipoids my own data illustrate. It is only two years ago that there existed but 28 complete blood-fat analyses which had been made upon all of my patients, and these were completed that year entirely through the kindness of Professor Bloor. Last year 131 similar analyses were performed by my assistant, now Lieutenant Horace Gray, also working in Professor Bloor's laboratory, but already within the first four months of this winter's work Miss Warren, in the laboratory of the New England Deaconess Hospital, has completed 116 determinations, though in this latter series only the fat by Bloor's method was sought, since this method appeared the best for clinical work. With the accumulation of these analyses, the ground is being broken for future therapeutic advances. In this connection may I emphasize the importance of the aid which the increased accuracy of chemical methods has brought to the treatment of diabetes? It is perhaps best shown

in the tests relating to acidosis, though valuable information has also come from a more intimate knowledge of the blood-sugar. In 1901 I journeyed all the way to Strasburg to learn from Professors Naunyn and Magnus-Levy, then Privat-docent, the most recent methods for measuring the acidosis of my patients. At that time the Schlossing test for ammonia was the most available, but that test required, after the collection of the twenty-four-hour urine, three days for its completion. Subsequently, Folin shortened the method to less than half an hour, but even then the test was performed at the end of a twenty-four-hour urinary collection, and though one might draw conclusions as to the quantity of ammonia by estimating the amount voided in shorter periods, the plan was seldom adopted. Contrast our armamentarium of today, when in ten minutes we can determine the degree of acidosis of our patient by the decrease in the carbon dioxid content of the alveolar air. And the method is so simple that I make a point of having all my diabetic nurses trained to perform it. I am glad of the opportunity of having it demonstrated here by Miss MacDougall, for I wish to impress upon you that it is with women that your competition will lie in the immediate future. In fact, all my chemical work now is performed by Miss Warren, Miss Amory, Miss MacDougall, and my secretaries, Miss Leonard and Miss Wood—such changes has the war wrought!

Both the Fridericia and the Marriott tests for the carbon dioxid content of the alveolar air are admirable, but the latter is more compact and has the advantage that it can be more easily applied to a child or an unconscious patient. The values obtained from it are a trifle higher than those obtained with the Fridericia apparatus.

Contrast the confidence with which a physician begins the treatment of a case of acid poisoning today with that of fifteen years ago. Today, by the Folin, or by another, the simple Malfatti test, one can quantitate the urinary ammonia within a few minutes, or, if preferred, by the determination of the carbon dioxid in the alveolar air can obtain a knowledge of the intensity of the acid poisoning on the spot. Forewarned is to be forearmed.

Since all cases of diabetic coma pass through a stage of acidosis as severe as the stage from which our little case was rescued, it is obvious that treatment of milder cases along similar lines ought to remove them from danger. This possibility I believe to have been attained. The statistics already cited furnish the proof for this statement.

Summary of Deaths from Diabetes at the Corey Hill and New England Deaconess Hospitals During 1917.—My own statistics for this last year show 181 cases treated at the Corey Hill and New England Deaconess Hospitals, with 4 deaths, or a 2 per cent. hospital mortality. These 4 cases are typical of many others, but they are so fresh in my mind that I will briefly summarize them. I am glad to do this, because it is from mistakes that one learns, and, furthermore, it is always wise for doctors who are constantly working with variables and uncertainties to come face to face with facts—and deaths are facts.

Case No. 1431, a little child who developed diabetes at the age of four years and four months in October, 1917, was put on the train 500 miles from Boston while showing the deep breathing of diabetic coma. This steadily increased until I saw her the next day for the first time at the hospital. She was conscious, had eaten eggs and bacon a few hours before, but was restless, and hyperpnea was evident to all. The regulation rules for the treatment of threatening coma which are in force at the hospital were adopted, but these proved to be of no avail, and the little child succumbed the following day. This is another one of the cases which has made me term *the first year following the detection of the disease the diabetics' danger zone. Had this child undergone "preparatory treatment," already described to you* (see page 903), *I believe the complication of acidosis thus early in the disease would not have arisen.*

The rules which have proved useful are given below. My experience with this child has made me add an eighth, now numbered "4," relating to gastric lavage. It is possible that if I had acted in accordance with it this patient might have been at least temporarily saved.

THE TREATMENT OF THREATENING DIABETIC COMA

Rules in Force at the Corey Hill and New England Deaconess Hospitals

1. *Nursing.*—Provide a special nurse for the patient both day and night, preferably, one trained in diabetic work.

2. *Bed.*—Keep the patient in bed and warm. Avoid loss of calories through exertion or exposure; if restless, protect from becoming chilled by flannel night-clothes. Every effort should be made to allay nervousness and discomfort.

3. *The Bowels.*—Move the bowels by one or more enemata. Cathartics should usually be avoided for fear of causing diarrhea.

4. *The Stomach.*—This should be free from indigestible food. With adults, when in doubt, but with children in all cases, begin treatment with gastric lavage.

5. *The Heart.*—Sustain the circulation with the help of digitalis. Caffein may be given subcutaneously, or as black coffee by rectum.

6. *Administration of Liquids.*—Give 1000 c.c. of liquids within each six hours. The liquids are to be given slowly, hot, as coffee, tea, thin broths, water; if the prospect is dubious of giving so much liquid by mouth, salt solution or tap-water is to be given by rectum; if this resource fails, the nurse should call the doctor to give intravenously the balance of the liter which remains not given for the period. (It will seldom be found necessary to give more than 1000 c.c. liquids, thanks to the avoidance of alkalis.) In order to secure the introduction of sufficient liquid in the first six hours the cleansing enema at the beginning of treatment should be followed after half an hour by an enema of 500 c.c. salt solution in all cases as a matter of precaution.

7. *Diet.*—If the patient has been accustomed to the fasting method of treatment, begin or continue the fast, but if he has been upon a full diet, give 1 gram of carbohydrate per kilogram body weight during the twenty-four hours in the form of orange-juice or gruel (oatmeal) made with water; whichever course is adopted, it is to be followed until danger is over.

8. *Alkalis.*—Avoid alkalis. If such have been previously given, omit at the rate of 30 grams a day.

Two of the deaths occurred in men—Cases Nos. 1381 and 1412. They so closely resemble one another that they can be described together. Each came to the hospital presenting, it is true, only moderate signs of acidosis, but excreting really enormous quantities of sugar in the urine—probably 1½ and possibly 2 pounds during the twenty-four hours immediately prior to entrance. The precaution was taken to omit fat at once and to prescribe a diet which contained about 200 grams of carbohydrate. In the one case, unfortunately, indigestion resulted from the vegetables employed, vomiting ensued, and was not stopped until acidosis had become so severe that it was not amenable to present-day treatment. This was all the more regrettable because it was a death during the first year of the disease. In the other patient even the restriction of the carbohydrate to 200 grams constituted so violent a change from the preceding diet that acidosis increased and death resulted. From the friends of this patient I learned that his disease was of three and three-quarters years' duration, and from himself that he had deliberately broken all bounds of diet for several months prior to admission to the hospital, claiming in justification, and with some show of reason, that he had eaten carbohydrate freely so as to avoid acidosis. *To cases like these in the future I shall be inclined to give as much carbohydrate in the diet as they excrete in the urine for each successive preceding twenty-four hours, and only then gradually lower the carbohydrate. This is exactly what I have urged in the preparatory treatment for fasting, but hitherto I have depended upon the statements of the patient as to the amount of carbohydrate in the diet; henceforth I believe it will be safer to be guided by the sugar actually excreted in the urine for the preceding twenty-four hours, twelve hours, six hours, or even less.* Such measures I hope will save many of these cases.

I am more skeptical about saving individuals like Case No. 1070, the fourth patient who died. She entered the hospital showing the deep respiration of beginning coma, with carbon dioxid content of the alveolar air equivalent to 11 mm. Hg. tension, remained under my care for twelve days, and then succumbed. In the interim the alveolar air rose to 16 mm. Hg.

This patient had been in the hospital sixteen months previously during the fifth month of her pregnancy, and at that time showed severe acidosis which was successfully treated by my assistant, now Lieutenant A. A. Hornor. She returned for a cesarean section, which was performed under local anesthesia by Dr. J. C. Hubbard, and during the succeeding year lived happily and brought up a healthy child.

Presentation of the Second Case.—The second patient, Case No. 1011, whom I am to show you, is slight and thin like our first case. She first noted polyuria and loss of weight in May, 1914, at the age of twenty-four years and ten months, but the disease was not diagnosed until five months later. A history of obesity or heredity was absent, but preceding the onset of symptoms was an attack of influenza of a few days' duration. Between October, 1914, and her first visit to me in March, 1916, glycosuria was absent for much of the time. Her weight was then 40 kilograms, in contrast to her highest weight recorded of 57 kilograms; the diacetic acid in the urine was +++, the sugar less than 1 per cent., and the alveolar air 25. The sugar fell to a trace upon fasting for two days, and following three days of feeding with 10 grams of carbohydrate, 21 grams protein, and 6 grams fat, and another fasting day, disappeared entirely, but acidosis persisted. It is interesting to contrast this case with the first case I brought before you, for from the diet of this patient fat was not totally excluded for a long period, and to this fact I attribute the persistence of acidosis for some six weeks. The patient was finally discharged after ten weeks, with the urine free from sugar and diacetic acid, and upon a diet of 5 grams carbohydrate, 63 grams protein, and 81 grams fat (Table VII).

She returned to the hospital in August, 1916, sugar and acid free, with the hope of increasing her tolerance for carbohydrate. This was accomplished so far as the urine was concerned, and she left on September 2d, taking 44 grams carbohydrate, 40 grams protein, and 63 grams fat, but I must acknowledge that the blood-sugar was 0.25 per cent. Her weight was then 31 kilograms.

Again in October, 1916, she returned for her third visit, this time with quite severe acidosis, which, however, promptly yielded

TABLE VII

THE CONDITION AT ENTRANCE AND DISCHARGE OF CASE NO. 1011 DURING REPEATED VISITS TO THE HOSPITAL

No. of visit.	Date.	Length of stay (weeks).	Condition at entrance.					Condition at discharge.				
			Urine.		Blood-sugar, per cent.	Alveolar air, CO_2 mm. Hg.	Wt., kilos.	Urine.		Blood-sugar, per cent.	Alveolar air, CO_2 mm. Hg.	Wt., kilos.
			Diacetic acid.	Sugar, per cent.				Diacetic acid.	Sugar, per cent.			
First	March 15, 1916	10	+++	0.6	0.28	25	40	0	0	0.24[1]	30	38
Second	Aug. 14, 1916	2½	0	0	0.27	34	33	0	trace	0.25		31
Third	Oct. 24, 1916	2½	++++	1.3	0.34	24	30	0	0	0.19	29[2]	29
Fourth	April 20, 1917	8	+++	1.6	0.28	22	28	0	0	0.12		31
Fifth	Sept. 25, 1917	12½	++++	4.5	0.33	15	26	0	0	0.08	34[3]	28

[1] Four weeks before discharge. [2] Five days before discharge. [3] Ten days before discharge.

to withdrawal of fat, and the sugar disappeared as well within nine days. At this time she left with a diet containing 6 grams carbohydrate, 42 grams protein, and 44 grams fat. The blood-sugar was 0.19 per cent., but the weight showed a steady fall to 29 kilograms.

A fourth visit to the hospital was made in April, 1917. This time acidosis was also severe and the sugar amounted to 22 grams over night. A prolonged fast of five days, save for a little alcohol, brought about the disappearance of acidosis, but sugar did not disappear until seven days later, during which period she was allowed a little protein and an insignificant amount of fat, a little alcohol, but no carbohydrate. She was discharged on June 15, 1917, this time with her lowest blood-sugar so far, namely, 0.12 per cent. Her diet was made up of carbohydrate 9 grams, protein 53 grams, and fat 61 grams, with 12 grams of alcohol. The weight was 31 kilograms.

However, the patient experienced much difficulty in keeping sugar free at home, and finally broke over the diet, returning to the hospital for a fifth time in September, 1917, with diacetic acid ++++, 4.5 per cent. of sugar, blood-sugar 0.33 per cent., and alveolar air 15 mm. Hg. Upon this occasion the diet prescribed was as nearly as possible that preceding entrance, but minus fat. This established the carbohydrate at approximately 100 grams and the protein at 67 grams. *The acidosis, which was not overcome for weeks on a former occasion, disappeared this time in three days (!)—a tribute, I take it, to the complete elimination of fat and the non-reduction of carbohydrate* (Table VIII).

Tests with High Carbohydrate Feeding and Variations in the Protein and Fat.—The patient had been through the fasting treatment so many times that both her parents and she now desired that a different method of treatment be adopted. This I felt proper, and I arranged a series of diets to be followed for periods of about ten days each, by the first of which the acidosis might be completely eradicated, and in subsequent periods the effect of protein and fat noted. I hoped by the complete elimination of the acidosis to lessen the severity of the diabetes as well. In a way, this was accomplished, for at the conclusion of the

TABLE VIII

SUMMARY OF FIFTH VISIT TO THE HOSPITAL OF CASE NO. 1011

Date, 1917.	Urine.				Diet, grams.					Balance.		Blood.		CO_2
	Volume, c.c.	Reaction.	Diacetic acid.	Sugar, gms.	Carbohydrate.	Protein.	Fat.	Alcohol.	Calories.	Carbohydrate.	Carb.-protein.	Sugar, per cent.	Fat, per cent. (Bloor).	Alveolar air, mm. Hg.
Sept. 25	specimen 20°		++++	4.5%								0.33		15
25–26	4400		+++	145										16
26–27	3200		+++	162	117	70	0	15	853	−45	−3			18
27–28	2100		++	101	99	67	0	15	769	−2	+38			19
28–8 Oct.	2602	acid	0	82	99	67	0	15	769	+17	+57	0.29		27
8–12	2950	acid	0	67	99	31	0	15	625	+32	+51	0.31	1.76	
12–13	3200	acid	0	83	99	36	28	15	897	+16	+48		1.326	34
13–24	3474	acid	0	78	99	36	40	15	1005	+21	+43	0.30	1.326	32
24– 3 Nov.	3538		0	99	129	29	40	15	1097	+30	+47	0.33	0.997	
3–14	3077	sl.	0	88	105	82	40	15	1213	+17	+66	0.29	1.094	31
14–22 Dec.	2967	acid	0	51	81	51	21	15	822	+30	+61	0.24	1.007	34
9–10	3400	neut.	0	0	0	0	0	23	161	0	0		1.161[1]	
10–13	2700		0	0	0	40	16	15	409	0	+24	0.12	1.206	34
13–14	2700		0	0	0	43	24	8	444	0	+26			
14–16	3250		0	0	0	45	31	8	515	0	+27			
16–17	2650	neut.	0	0	0	53	36	8	592	0	+32	0.08		
17–18	3700	sl.	0	0	0	0	0	23	161	0	0			
18–22	2413	acid	0	0	1	53	36	8	696	+1	+32			

periods the existing glycosuria of 50 or more grams disappeared with a day and a half of fasting, in contrast to the prolonged periods required to accomplish this end at her former visit.

In Table VIII you will note that acidosis disappeared within three days when fat was removed from the diet, and the patient given a quantity of carbohydrate not far from what she had been taking outside. For example, in the first twenty-four-hour period, September 26–27, 117 grams were given, but there appeared in the urine 162 grams, giving a minus carbohydrate balance of 45 grams. On the following day, when the carbohydrate was changed to 99 grams, this minus balance dropped to minus 2 grams, and during the subsequent ten days, when the diet was essentially the same, changed to a positive average daily carbohydrate balance of 17 grams. If we look at the matter in

[1] December 4th.

another way and add to the 17 grams the carbohydrate which could be formed out of the 67 grams protein allowed, on the basis that for each 100 grams protein 60 grams carbohydrate are produced, the carbohydrate balance would be still higher, and would be as follows: Carbohydrate 99 grams + carbohydrate formed from protein (67 grams × 60), 40 grams = 139 grams, minus the 82 grams sugar excreted daily in the urine = 57 grams —that is, a daily positive combined carbohydrate balance of 57 grams.

During the period October 8–12 the protein was reduced to 31 grams, and although the carbohydrate balance rose to 32, the carbohydrate balance of the carbohydrate and protein together fell. Between October 13th and 24th, without essential change in the protein, nearly 400 extra calories in the form of fat were added to the diet. The carbohydrate balance was essentially the same as that on the carbohydrate and low protein diet, and the carbohydrate balance based on combined carbohydrate and protein intake improved. Between October 24th and November 3d 30 grams additional carbohydrate were given, leaving the protein and fat essentially the same. However, this was disadvantageous, for two-thirds of it appeared in the urine. The carbohydrate was then put back to 105 grams between November 3d and 14th, and the protein raised to approximately 3 grams per kilo of body weight, and the fat unchanged. As a result the carbohydrate balance dropped, but the carbohydrate-protein balance reached its highest figure. The final change in the diet was made, preliminary to getting the patient sugar free by fasting, by lowering the carbohydrate to 80 grams, and giving 1.5 grams protein and about 1 gram fat per kilo of body weight. On this diet both the carbohydrate balance and the carbohydrate-protein balance remained high, and this seemed to be the best arrangement of all. Following fasting the patient finally attained a diet containing 1 gram carbohydrate, 53 grams protein, 36 grams fat, and 8 grams alcohol, making 696 calories, without showing sugar in the urine, and having remained sugar free upon it for some days, she was allowed to go home.

During these various tests you will see that experiments were made with carbohydrate, with large and small quantities of protein, with fat absent, and with fat present in moderate amounts. Throughout all these changes acidosis remained absent, and while upon a diet of 80 or more grams carbohydrate a positive carbohydrate balance was maintained. The food-supply appeared ample because the large quantity of carbohydrate allowed so much bulk. Yet—and to this I call your especial attention—if one estimated the net calories retained by the patient by deducting the amount of calories lost as sugar in the urine, you will see that the diet was still an undernutrition diet. Subsequent to the brief fast the patient was able to take a few grams of carbohydrate, and though the caloric intake was lower than before, the net calories approximated the same as when the high carbohydrate diet was allowed.

At the conclusion of these observations independently both the patient and I agreed that the high feeding, although more agreeable than fasting, had been distinctly harmful so far as the diabetes was concerned, but upon the acidosis the effect had been favorable. No case has been treated similarly by me, and I have followed no case and know of none accurately followed under precisely these conditons. The tests which this patient was glad to have made, however, prove one point, that the elimination of fat and the allowance of carbohydrate do cause an essential change in the metabolism of a diabetic, and to be conservative, allow us to say at least this—that whereas such a patient with restricted dieting became sugar free only after periods of many days, upon a diet with restricted fat but high carbohydrate it was possible with a subsequent fast to become sugar free in a few days.

Efforts to Reduce the Blood-sugar to Normal.—If you will glance at Tables IV, V, VII, and VIII you cannot fail to be impressed with the high percentages of blood-sugar despite the fact that these patients have been under my care for several years. Occasionally the values have fallen to nearly normal, but it must be confessed that treatment has not been satisfactory in this regard. In a conference with Dr. Allen, he was good enough

to point out that in some of his cases he had been able to secure a normal blood-sugar when the patients lived upon an undernutrition diet with food exclusively in the form of protein. By this means during the period of underfeeding the body strength was, to a considerable extent, sustained. Adopting his suggestion with both of these patients, you will see that I have had more success than hitherto, for the blood-sugar of Case No. 1011 in this way was brought to normal and the blood-sugar of Case No. 1012 fell perceptibly, unfortunately to rise on the morning of discharge, when the diet was carbohydrate 3 grams, protein 55, fat 40, and alcohol 5 grams.

There is little doubt that if the blood-sugar is normal there is less liability of the return of glycosuria. Repeatedly I have been mortified upon sending patients home after they have been sugar free in the hospital for several weeks to learn a few days later that sugar had returned, although no change had been made in the diet. Therefore, if one can secure a sugar-free urine, which has been hitherto our standard of treatment, by keeping the blood-sugar normal one will feel far more at ease.

It is still a question with me whether it will be advisable to take such heroic measures to keep the blood-sugar constantly normal. My reason for hesitation in this regard is that patients who have had diabetes for years, yet only occasionally developing glycosuria, often show an increased quantity of sugar in the blood and yet appear in excellent condition. Perhaps this is due to the impairment of their kidneys. To reduce the blood-sugar to normal in these patients would probably require extremely strenuous measures, and before I should adopt such a plan as a routine I should wish to try it out first in a moderate way. Fortunately, with the increasing ease with which blood-sugar determinations are being performed, there is little doubt but that new light will soon be shed upon this point.

Efforts to Reduce the Blood-fat.—The blood-fat is far less easily brought down to normal than the blood-sugar. Our first patient is an example in point. With Case No. 1415, for example, showing a blood-fat on October 20, 1917, of 2.8 per cent., although she has been on a low diet and one containing

very little fat, and although the blood-sugar has dropped from 0.31 to 0.10 per cent., the blood-fat still remains (December 12, 1917) at 2.17 per cent.[1] On her prolonged low diet, tolerance has risen, and she now enjoys 28 grams carbohydrate. I hope that gradually the blood fat will fall, for I can hardly believe that her diabetes is under control with a blood-fat three times the normal. It is certainly gratifying to see her walk about, because prior to her entrance to the Corey Hill Hospital she had not been able to dress herself or walk for ten months. Here again routine laboratory tests will give us data which will be of inestimable advantage. The simplification of the method for the estimation of blood-fat which Prof. Bloor has wrought must yield large results. All these improvements, however, really represent improvements in degree rather than radical advances in treatment, but I am so confident that our modern methods of treatment of diabetes are satisfactory for the overwhelming majority of cases that, although not content with the gains which are being made, I am at least encouraged by them.

Changes in Weight.—Case No. 1012. This case showed such remarkable changes in weight during the first twenty days in the hospital as to deserve your notice. The increase amounted to 25 per cent. One not experienced in the treatment of diabetes might at first conclude that a wonderful progress was being made by the patient. Physical examination, however, would quickly dispel this illusion, for edema was marked within eleven days of her entrance. Furthermore, the total quantity of food which the patient ingested for these twenty days furnishes proof that the gain in weight could not have been gain in body tissue, for the calories consumed, not allowing for those lost in the urine in the form of sugar, amounted to 5.5 calories per kilo per twenty-four hours, and if we reckon the net calories, this figure is reduced to 2.9 calories.

One should invariably take into account such collections of water in the body when arranging the diet. Obviously, this accumulated water should not be reckoned in the same way as body tissue so far as relates to body requirements for food. This

[1] One month later it had fallen to 1.5 per cent.

is often overlooked in our estimations of the needs of the patient, and, furthermore, overlooked in reckoning the metabolism of such patients from day to day. When one considers that the gain in weight amounted to 25 per cent., it is obvious that unless attention is paid to this possibility conclusions as to the total metabolism of an individual, if reckoned per kilo of body weight, would be far askew. This point strikes me as a very important one, and I do not remember to have ever seen it receive the attention it deserves.

The Total Metabolism.—The metabolism of patients with severe diabetes has interested Professor Benedict of the Nutrition Laboratory of the Carnegie Institution of Washington situated here in Boston and myself for many years. This patient, Case No. 1011, has frequently been a subject for study, and during her present stay at the hospital 16 tests of more than two hours' duration each have been made of her metabolism in the respiratory chamber in the Respiratory Laboratory fitted up by the Carnegie Institution at the New England Deaconess Hospital. One-half of these tests were made in the postabsorptive period—that is, at 8 o'clock in the morning, approximately fourteen hours after the last meal. The balance of the tests were made either after breakfast or after the noon meal. Many interesting data were observed, but in this place it is appropriate to discuss only the general features, and I do this with reserve, because as yet Professor Benedict and I have not discussed them in detail or submitted the data to final corrections.

The total metabolism was determined in each experiment, and as you are more familiar with the caloric requirements of the normal individual per kilo of body weight for twenty-four hours, I am giving the results in this form, though in reality it is more correct, in describing metabolism for a limited period, to report the results in calories per hour. The average heat production per kilo of body weight on a twenty-four-hour basis for the eight postabsorptive experiments was 28 calories per kilo per twenty-four hours. The latter two observations were 26 and 25 calories respectively, whereas the earlier six experiments showed a variation between 28 and 32 calories. The departure of any of the

figures, however, from the average above mentioned was not great, even with the wide variations of diet prescribed. The difference between the earlier and later figures is distinct, but not sufficiently striking to warrant me in drawing definite conclusions at the present time. In general, it may be said that the metabolism did not essentially differ from normal individuals of similar size and weight.

The metabolism following the ingestion of food showed wider variations, for the lowest observation showed an output of 29 calories per kilogram of body weight per twenty-four hours, and the highest 40, the average being 33. Here again the metabolism for the last two observations, like that of the last two postabsorptive experiments, tended to the lower limits, being 29 and 32 calories respectively. The striking increase in metabolism following a meal is a hopeful phenomenon, for it shows that this diabetic subject will still respond to food.

The respiratory quotient also furnishes proof that food was utilized. You will remember that the relation of the volume of carbon dioxid exhaled to the volume of oxygen absorbed in any given period constitutes the respiratory quotient. This will amount to 1.00 when carbohydrate ($C_6H_{12}O_6$) is burned, because enough oxygen is present in the molecule to combine with the hydrogen and all the oxygen required for oxidation may unite with the carbon. But with protein the respiratory quotient drops to 0.81, because extra oxygen is required for oxidation of the non-carbon atoms in the protein molecule, and this is still more the case with fat, for so much oxygen is demanded that the respiratory quotient drops to 0.71. The most interesting feature about this patient is the high respiratory quotient which she presented even after fasting. We think of a severe case of diabetes —and certainly this was such—as devoid of carbohydrate reserve supply and as unable to burn carbohydrate, and formerly the average respiratory quotient of such patients was found to be about 0.73, yet this patient was able to maintain a respiratory quotient consistent with the burning of large quantities of carbohydrate. The explanation of this phenomenon remains an enigma, and is one of the most interesting puzzles of the diabetic

problem today. The average of the eight observations on the respiratory quotient in the postabsorptive area was 0.82, while the average of the eight observations upon the respiratory quotient after the ingestion of food was 0.88—so great an increase and so far above the respiratory quotient for protein that one could not explain it as due to protein. The high postabsorptive respiratory quotient of the diabetic unable to ingest carbohydrate without the appearance of sugar in the urine, and therefore living upon protein and fat, is difficult to explain, and the explanation of this further rise in the respiratory quotient after food is certainly not easier.

These two patients whom I have shown you, as trustworthy as any who are likely to come under your supervision, illustrate the difficulties with which one must contend in diabetes. Each, in my estimation, has withstood the disease longer than other diabetic patients under my care of equal intensity. Each has pushed the boundary of life a little farther, and in so doing has helped to advance treatment. By living they have helped lower a hospital mortality which has averaged 27 per cent. yearly for ninety years to a hospital mortality of 2 per cent.—certainly no mean achievement. Their recovery from severe acidosis is unusual, and that it should have taken place without the use of alkalis is more than any of us would have thought possible three years ago. The persistence of the high blood-sugar, and yet the demonstration of its being lowered by undernutrition and a protein diet, as suggested by Dr. Allen, deserves consideration. The resistance of the blood-fat to treatment gives a distinct problem for future work. The harmfulness of high carbohydrate feeding upon the disease diabetes, but its usefulness when combined with the exclusion of fat from the diet in the overthrow of severe acidosis appears plain. The temporary gain in weight due to edema, amounting in one of the patients to 25 per cent., should be mentioned. The approximately normal metabolism, including a respiratory quotient also not far from normal both in the postabsorptive and after food periods, are facts which deserve the closest scrutiny and present problems which

only intelligent and prolonged experiments can solve. Whereas the two cases are evidence of real progress in the treatment of diabetes, I am sure you will agree with me that the need for new discoveries in the management of such patients is imperative.

CLINIC OF DR. JOHN LOVETT MORSE

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EMPYEMA IN CHILDREN: DIFFERENTIAL DIAGNOSIS AND TREATMENT

November 30, 1917.

GENTLEMEN: The case which I am going to discuss with you today seems to me a very interesting and instructive one because it illustrates so well the importance of a thorough physical examination and the careful and intelligent analysis of symptoms and signs.

This little boy, who is four and a half years old, is the first child of healthy parents. There is no tuberculosis in either family, and he has had no known exposure to tuberculosis. He has always been subject to "colds," but has not had one since his tonsils were removed last February until the beginning of his present illness. His general condition has also been much better since that time.

He was taken suddenly sick with what was apparently a "cold," October 22d. His temperature rose to 103° F., and his pulse and respiration were rapid. He developed a slight cough the next day. The temperature, pulse, and respiration were all normal on the 24th. Physical examination showed nothing abnormal in the lungs. His temperature rose again to 104° F. October 25th. It continued between 103° and 104° F. and, according to his physician, signs of bronchopneumonia developed on the right side on October 28th. He complained considerably of pain in the right chest in front. About the first of November his temperature began to break in the morning, and since that time has ranged between normal in the morning and 102° and 103° F. in the afternoon. During this time

his pulse has been about 140 and his respiration 40. The doctor says that the signs have persisted in the right chest and that recently they have seemed to him more like those of lobar pneumonia than of bronchopneumonia. The cough has continued and he has at times perspired profusely and has had slight chills. He has lost a great deal of weight and has taken his food very poorly. He vomited rather frequently in the beginning, but during the past week has not vomited oftener than once a day. He had six or eight loose stools daily up to two weeks ago, since when he has had only one or two daily. The abdomen has been distended at times. He was brought to the hospital yesterday, November 29th.

The so-called "cold" which he had October 22d and 23d may have been either an acute infection of the nasopharynx, as was supposed, or the onset of the illness which began October 25th. On the chances, it is probable, because of the normal pulse and respiration on the 24th, that it was simply a "cold" and the forerunner of the real illness which began on the 25th. The diagnosis of bronchopneumonia on the right side which his physician made on the 28th seems hardly reasonable, because bronchopneumonia seldom comes on so acutely, does not ordinarily run a continuously high temperature, is almost never limited to one side, and is usually not accompanied by pain. Moreover, localized pain in respiratory affections usually points to an inflammation of the pleura on the affected side, and acute pleurisy is uncommon in bronchopneumonia. The story is far more consistent with the diagnosis of lobar pneumonia, for which the sudden onset, the continued high fever, the limitation of the process to one side, and the localized pain are most characteristic. The continuence of the high temperature without remissions until November 1st, seven days after the onset, when it began to break, is also very characteristic of lobar pneumonia. The irregular temperature during the last four weeks is consistent with bronchopneumonia, but it is not reasonable to suppose that the lesions of bronchopneumonia would remain localized in one lung all this time. Neither is it reasonable to believe with the physician that lobar pneumonia has taken the place of bron-

chopneumonia, especially when we take the irregular temperature into consideration. It is far more reasonable to believe that the physician is weak in physical examination and, therefore, to pay little attention to his findings and conclusions.

It is safe to conclude, then, that the boy had an attack of lobar pneumonia on the right side between October 25th and November 1st, and that the irregular temperature is due to some sequela of this attack. The chills and sweating suggest very strongly that there is a collection of pus somewhere in his body. They make it very improbable that the persistence of the signs in the lungs is due simply to an unresolved pneumonia. The facts that he has probably had lobar pneumonia, that abnormal physical signs have persisted on the right side, and that the rate of respiration has continued to be increased out of proportion to that of the pulse point very strongly to the right chest as the seat of this collection. If it is in the right chest, it may be either in the lung or in the pleural cavity. It is far more likely to be in the pleural cavity than in the lung, because purulent pleurisy is far more common than abscess of the lung. It is possible, however, that the pus may be located somewhere else, most likely in the middle ear or in the pelves of the kidneys, although the absence of all symptoms pointing to the ear makes it improbable that it is located there. Another possibility is that the trouble in the lung is tubercular. If so, it may have been tubercular from the first, or a primary pneumonia may have lighted up a pre-existing tubercular process. The absence of a tubercular family history and of known exposure to tuberculosis does not, of course, count in any way against this possibility, as at least 25 per cent. of all children of this age are infected with tuberculosis. The present symptoms are all consistent with this diagnosis. The chances are very much against it, however, as empyema is far more common after lobar pneumonia at this age than either an acute tubercular pneumonia or a secondary tubercular infection of the lungs. The loss of weight, the anorexia, the vomiting, the diarrhea, and the abdominal distention are all secondary symptoms and consistent with any of the possibilities. We approach the physical exam-

ination, therefore, expecting to find an empyema on the right side.

He has, as you see, evidently lost a great deal of weight. He is moderately pale. He is evidently perfectly clear mentally. His tongue is considerably coated. His throat shows nothing abnormal. His ear-drums are normal. The cardiac impulse is palpable in the fourth space, 7 cm. to the left of the median line. The left border of dulness corresponds to the impulse. It is impossible to locate the right border of the heart because of the flatness in the right chest. The action is regular and the sounds normal. The sounds are as loud to the right as to the left of the sternum. The second pulmonic sound is considerably accentuated. The right chest moves less than the left. There is no bulging of the intercostal spaces, and there is no apparent difference in the size of the two sides. There is tympany in the right front above the second rib. There is flatness below this and in the axilla and over the whole right back. The respiration is nearly normal in the tympanitic area. It is loud and bronchial over the flat area in front, diminished and bronchovesicular in the axilla and back. It is impossible to make out anything as to the voice sounds and tactile fremitus, because he will not talk and whines instead of crying. There is a very marked sense of resistance all over the flat area. Grocco's sign is absent. There are no râles. The left chest shows nothing abnormal, except that it is slightly hyperresonant and the respiratory sound is exaggerated. The abdomen is a little full, but otherwise normal. The liver is palpable 3 cm. below the costal border in the nipple line. The spleen is not palpable. The genitals are normal. The extremities show nothing abnormal. There is no spasm or paralysis. The knee-jerks are equal and normal. There is no Kernig's sign. There is no enlargement of the peripheral lymph-nodes. His rectal temperature is 102° F., his pulse 140, and his respiration 40.

The urine is high in color, acid in reaction, of a specific gravity of 1026, and contains no albumin or sugar.

The leukocyte count is 24,000.

The sputum has not been examined.

The tuberculin test was not done until this morning, too late to be of any assistance to us.

The physical examination shows conclusively that the seat of the trouble is in the right chest. The normal condition of the ear-drums shows that he has not got otitis media. The examination of the urine shows nothing more than concentration and excludes pyelitis. The accentuation of the second pulmonic sound means simply that there is increased resistance in the pulmonary circulation as the result of the lesion in the right lung and tells us nothing as to the nature of this lesion. The hyperresonance and the exaggerated respiratory sound on the left signify a compensatory enlargement of the left lung.

In view of the possibilities in this instance the first thing for us to determine is whether there is solidification of the right lung or fluid in the pleural cavity. After this has been decided, we will try to find out in other ways what is the cause of the solidification of the lung, if this is present, or what is the character of the fluid, if there is fluid. If there is an abscess of the lung the signs will be those of solidification of the lung, modified to some extent, rather than those of fluid in the pleural cavity. The fact that the right side does not move as much as the left in respiration does not help us any in this diagnosis, as it shows only that there is trouble in the right side, not what this trouble is. The absence of apparent enlargement of the right chest and of bulging of the intercostal spaces does not rule out the presence of fluid, but merely shows that there is probably not a large amount. The location of the cardiac impulse, 7 cm. to the left of the median line, and the fact that the heart sounds are as loud to the right as to the left of the sternum, show that the heart is in normal position. This point counts strongly against an effusion, but does not positively rule it out, because the heart may have been bound down by adhesions before the effusion formed. The absence of Grocco's sign is another point against effusion. It shows that the mediastinum is not displaced, but does not exclude an effusion, because the mediastinum is not displaced unless there is a considerable amount of fluid, and displacement may be prevented by adhesions. The fact that the liver is pal-

pable 3 cm. below the costal border in the nipple line at first suggests that it is displaced downward by fluid in the pleural cavity. As a matter of fact, however, the liver is not displaced downward by effusions in the right pleural cavity unless they are enormous, and seldom then. In this instance we already know from the absence of enlargement of the right side and bulging of the intercostal spaces that this is not the case. The abnormal position of the lower border of the liver must be due, therefore, to enlargement of the liver rather than to displacement downward. This enlargement is undoubtedly the result of the long-continued fever and the toxemia, and is, in all probability, due to fatty change, as it is too early for amyloid change to have taken place, even if there is pus in the pleural cavity.

The flatness in the right chest is consistent with either solidification of the lung or a pleural effusion. The tympany above the second rib is also consistent with either condition, being due presumably to loss of tension in the lung tissue. In the case of fluid this loss of tenison would be due to compression; in that of solidification of the lung, to compensatory emphysema. The normal character of the respiration at the apex is easy to explain if the lung there is simply emphysematous. If it is compressed by fluid, the sound should be bronchial. It is possible, however, that the normal vesicular sound is transmitted from the other side. The loud bronchial respiration in front is characteristic of solid lung. It is not inconsistent with a pleural effusion, however, because in children it is not at all uncommon to have loud bronchial respiration when the chest is full of fluid, probably because of the elasticity of the chest. It is difficult to explain the diminished bronchovesicular respiration in the axilla and back on the basis of solidification of the lung. If there is thickening of the pleura over a solid lung, the respiration might be diminished, but it should be bronchial. If there is no thickening of the pleura, the respiration should be loud and bronchial. It is also hard to explain the bronchovesicular character of the respiration if there is fluid in the pleura. This would, of cqurse, explain the diminution in the intensity of the respiration, but the respiratory sound, coming from a compressed lung, should

be bronchial, not bronchovesicular. It is possible, however, that the bronchial sound from the compressed lung may be modified by the vesicular sound transmitted from the left lung. We shall have to get along without the assistance of the voice sounds and tactile fremitus, because he will not talk and whines instead of crying. The absence of râles is somewhat against solidification of the lung and in favor of an effusion into the pleural cavity, because, after five weeks, no matter what the cause of the solidification, there would probably be some breaking down of tissue or irritation of the bronchi, which would give râles. The very marked sense of resistance over the whole flat area is of great importance in diagnosis. By the sense of resistance I do not mean the sensation imparted to the plexímeter finger during ordinary percussion, but the feeling of resistance which is met when the chest is struck with the whole of the extended fingers, not with their tips. When the chest is struck in this way and the lungs are normal, there is a feeling of elastic resistance. When the lung is solidified, the feeling of elasticity is lost and the resistance is more definite. When there is any considerable amount of fluid in the pleural cavity the feeling of resistance is increased and becomes very marked. The sense of resistance is the same as that which is felt when the thigh is struck in the same way. It is the same whether the effusion is serous or purulent. Next to the presence or absence of displacement of organs it is to me the most important single sign in the diagnosis between solidification of the lung and pleural effusion.

Let us now sum up the results of our physical examintion of the chest and see if we can make up our minds from them whether there is solidification of the right lung or an effusion into the right pleural cavity. The findings obtained by percussion and auscultation of the right side are unimportant and must be disregarded, because they can be interpreted as consistent or inconsistent with either condition. The absence of enlargement of the right side and of bulging of the intercostal spaces is slightly against fluid. The absence of râles is slightly in favor of fluid. The normal position of the heart and the absence of

Grocco's sign are decidedly against fluid, while the very marked sense of resistance is very strongly in favor of fluid. The diagnosis thus depends almost entirely on the relative importance which we attach to the absence of displacement of organs on the one hand, and the marked sense of resistance on the other hand. It is easier to believe that the displacement of organs has been prevented by the formation of adhesions before the effusion became large enough to displace them than that the very marked sense of resistance is due to solidification of the lung. I feel very confident, therefore, that there is an effusion in the right chest.

Let us see now whether the laboratory findings are of any assistance to us either in confirming or disproving our diagnosis made on the history and physical examination. The white count of 24,000 is consistent with any and all of the conditions considered except a serous pleurisy, which almost always has a low white count. Even if the condition was tuberculosis of the lung, there would almost certainly be a mixed infection by this time and, therefore, a leukocytosis. The white count does not help us any, then, except in that it makes a serous effusion improbable. An examination of the sputum would not help us any unless tubercle bacilli were found in it. If they were found, we would know that he had tuberculosis of the lung, but we should not know whether he had also an effusion or not. If they were not found, we would be no better off than we are now. A negative tuberculin test would be strong evidence against the trouble in the chest being tubercular, but would not exclude it, because he is so ill that he might not react, even if it was tubercular. A positive test would, moreover, be of little importance, because at least 25 per cent. of all children of this age have been infected with tuberculosis. We get little or no help, therefore, from the laboratory findings. A Roentgen-ray picture would also be of little or no assistance in this case, because all of the conditions under consideration would give a dense shadow.

Having come to the conclusion that there is an effusion in the right pleural cavity, it is our duty to explore the chest to

verify the diagnosis because, if there is a serous effusion the fluid should be drawn off, and if it is purulent he should be operated upon at once. From the evidence which we have what sort of fluid ought we to expect to get? It will almost certainly be purulent if our reasoning has been correct. It is, we believe, secondary to lobar pneumonia, and in children such effusions are almost invariably purulent. The white count is strongly in favor of pus, and the irregular temperature, chills, and sweating are more characteristic of a purulent than of a serous effusion.

In general it is wise to introduce the needle in the place where the signs of fluid are most marked. In this instance it will probably make very little difference where we put it in, because he either has a chest full of pus or there is none in it. One of the best places to put in a needle, however, is in the scapular line in the seventh or eighth space, because it is an easy place to get at, the intercostal spaces are wide in this region, and there will surely be fluid there, if anywhere. We will, therefore, stick it in there. We will use a large needle, because, if the pus is thick, it will sometimes not run through a small needle. We will not use any local anesthetic, because that will hurt him and frighten him as much as the prick of the needle. The house-officer will hold him firmly, sitting up in his lap, with his left side toward him and his right arm stretched up in order to widen the intercostal spaces. We will now wash up the lower right back with soap and water and alcohol. Up to this time you will notice that nothing has been done to suggest to him that anything more than an examination is to be done. I am now going to tell him that I am going to prick him hard with a needle and that it will hurt him some, but only for a minute. He will find that this is true, and when I tell him in the future that I am not going to hurt him he will also believe that. Remember, never tell a child that you are not going to hurt him when you know that you are. If you do, he will never trust you afterward. If you always tell him the truth, he will always have confidence in you and you can do anything with him. If you deceive him, he will regard you in the same light as you yourselves do other liars. As I am simply going to explore his

chest, I shall use a needle attached directly to a syringe instead of an aspirator. This makes the operation much more simple, shortens the time, and diminishes the shock and fright.

The syringe is, as you see, full of thick, greenish-yellow pus, which confirms our diagnosis of empyema.

There is no question as to what ought to be done now. He should have a rib resected at once and the chest thoroughly drained. It is true that once in a great while an empyema can be cured by repeated tappings. This happens so seldom, however, that it is not only idle, but almost criminal to consider it. Simple incision between the ribs does not afford the free drainage that is possible when a rib is resected, and free drainage is necessary for a cure. The resection of a rib is a simple operation which takes but a little time, so that the shock of this operation is but little greater than that when a simple incision is done. If the resection is properly done, new bone will fill in the gap in the rib. A resection of a rib should always be done, therefore, rather than a simple incision, except in the very rare instances in which the child is too feeble to withstand the slight additional shock of the resection. In such instances a rib should be resected later. This boy is in relatively good condition and perfectly well able to stand a resection. We will therefore transfer him to the surgical side for immediate resection of a rib.

He will probably recover, because his digestion is now fairly good and his kidneys and heart show no evidences of infection. I fear, however, that it will be a good many weeks before the inflammation in the pleura will subside and the wound heal. I fear this, because I feel quite sure that, on account of the long duration of the inflammatory process in the pleura, adhesions have formed which are binding down the compressed lung. The normal position of the heart and the absence of Grocco's sign, taken in connection with the evidences of the large amount of fluid in the pleural cavity, confirm me in this belief. These adhesions will interfere with the rapid expansion of the lung and will delay the healing of the pleura. It is possible that they will prevent a complete expansion of the lung and that he will eventually recover with a permanent deformity of the right chest and more or less scoliosis.

CLINIC OF DR. W. P. GRAVES

HARVARD MEDICAL SCHOOL

OVARIAN ORGANOTHERAPY

Gynecologic Cases Representing Deviations in the Physiologic Pelvic Function and Their Treatment by Organotherapy; Varieties of the Disturbances, Clinical Manifestations, and the Management of these Cases; Several Case Reports.

IT is my purpose to demonstrate several cases typical of those gynecologic conditions that are amenable to ovarian organotherapy.

It is often claimed that in the present status of gynecologic science medicine has no place and that the specialty has developed almost exclusively into a branch of general surgery. This is to a certain extent true and seems likely to remain so in those departments which deal with new growths, destructive inflammatory processes, and conditions requiring mechanical reconstruction. In the surgical field most of the problems have been fairly satisfactorily worked out. There remains, however, a vast number of gynecologic cases which represent deviations in the physiologic pelvic functions. In the treatment of such cases surgery, like medicine, has proved, for the most part, a conspicuous failure, and it is exactly in this direction that the future proggress of gynecology must lie. I refer especially to those disturbances which relate presumably to disorders of the ovarian function, and include such conditions as menorrhagia, amenorrhea, menstrual clotting of blood, dysmenorrhea, sterility, genital atrophy, and a long series of nervous and vasomotor manifestations which result from under- or overfunctioning of the genital glands. Up to the time of the discovery of the ovary as an organ

of internal secretion the understanding of these distrubances was involved in the deepest mystery. Studies of the secretory influence of the ovary in pelvic physiology threw some light on the subject, but the intricacy of the problem was only fully realized when it was found not only that the sex organs possess a very intimate relationship with the other endocrine glands, but that the other glands exert an important influence on the genital system independent of the ovaries, and may themselves be regarded to a greater or less degree as sex organs.

The enormous amount of experimental and clinical work done in endocrinology has up to the present time produced results of comparatively little practical significance, but what knowledge has been gained is of such nature that it promises much greater things for the future.

The ovary, among the glands of internal secretions, labors at a peculiar disadvantage, for the function of menstruation, in which from a practical standpoint we are chiefly interested, is almost exclusively a human attribute. In the study, therefore, of menstruation and all the numerous conditions associated with it we are limited to purely clinical observations with little aid from the more exact methods of laboratory and animal experimentation. One of the most important means that we at present have for studying human pelvic physiology consists in observing the influence of ovarian organotherapy on functional disturbances. This is admittedly an inaccurate method of research, for it involves many unavoidable chances for error. In addition to our theoretic ignorance of the nature of the active ovarian substance, we are handicapped by the wide differences that exist in individual human reaction to drugs. Moreover, statistical results of our work must depend on the verbal or written statements of patients who inevitably vary much in their interpretation of symptoms. These and other chances for error must be taken into account, and conclusions should not be too enthusiastically drawn one way or the other without weighing a large number of observations.

The first cases that I will bring to your attention represent the vasomotor disturbances that ensue after hysterectomy with or without the ablation of the ovaries. These manifestations

have been termed the "symptoms of the artificial menopause." They are analogous to but by no means identical with the natural menopause symptoms, for they are more constant, more distinctive, of shorter duration, and of more limited scope than the latter. They are also more amenable to ovarian therapy. In this particular field the efficacy of ovarian therapy can no longer be doubted, after making allowances for every possible error, for the results are so constant and so universally obtained by different practitioners and with different preparations that it may be confidently stated that there exists in the ovary a substance which specifically relieves ablation symptoms.

The fact that ovarian therapy sometimes fails in these cases does not necessarily weaken our conclusion, as is evidenced in the following case history:

The patient is a single woman of thirty-nine, who for a number of years has been employed as a physician's private secretary. She is naturally of rather a nervous, high-strung disposition, but is intelligent and sensible and keeps her nervous inclinations under good control. About three years ago I performed a hysterectomy with ablation of the ovaries for a chronic pelvic condition which had kept the patient ailing for several years. The convalescence was normal and the general condition of the patient improved by the operation. Ablation symptoms were, however, peculiarly severe and persistent. Instead of subsiding in two or three months, as is usually the case, they continued to be troublesome. During this time the patient consulted me for hot flushes and I prescribed an extract made from the whole ovary, a special preparation that I had found particularly efficacious for cases of this kind. She got little relief, however, from this prescription, and finding it too expensive, she bought from time to time nondescript extracts at the cheaper drugstores. She also tried several preparations prescribed by the physician for whom she worked, but all without relief. Finally, at the end of a year and a half, she consulted me again. The hot flushes had continued unabated and were now having a rather serious effect on her nerves. I had at this time begun trying out a new extract especially prepared for me, consisting of the dried residue of

pregnant ovaries from which the corpus luteum had been removed. The relief from this preparation was immediate and striking.

This case illustrates well an observation that I have frequently made in the treatment of ablation symptoms, namely, that patients exhibit idiosyncrasies to certain types of ovarian therapy. Thus some patients, as in the case just described, react specifically to the ovarian residue of pregnancy, others to the whole ovary, and still others to the corpus luteum. I can offer no adequate explanation for this. The milder cases of ablation symptoms yield to almost any of the better preparations, but in the severe cases it may be necessary to try several extracts before the right one is found.

The next case that I will present is similar to the first. These two are the worst cases of artificial menopause symptoms that I have had in recent years, and I wish to call your attention to them especially in order to demonstrate the possibilities of ovarian therapy.

This patient is a trained nurse, thirty-eight years old, much like the first case in physique and general temperament. She also was obliged to undergo a hysterectomy with ablation of both ovaries about a year and a half ago. The operation was followed by troublesome hot flushes which did not subside at the usual time. She had moved to a distant town, so that I had been unable to follow the case. She finally consulted me by letter, and I sent her at various times ovarian and lutein preparations, none of which had any appreciable effect. The dried ovarian residue which was so successful in the first case failed completely with this patient. Meanwhile the firm which had supplied me with the dried residue had prepared the same substance in ampule form for hypodermic injections. I first tried this form of treatment with this patient. Being a nurse, she was able to administer the injection herself. A recent letter reports an immediate satisfactory improvement in her symptoms.

In this case we see how a substance which when ingested in dried form was ineffective, at once produced the desired reaction when introduced in fluid form directly into the circulation.

This is as would be expected, for undoubtedly the active material of the ovarian substance must be deleteriously affected to a greater or less extent by the processes of digestion and absorption.

The next case illustrates the effect of ovarian therapy on an unusual form of vasomotor disturbance. The patient is a society woman of forty, from whom the pelvic organs were removed for uterine and ovarian disease about eight months ago. She made an excellent convalescence from the operation, but about three months later began to have hot flushes—a somewhat unusual circumstance, for they commonly appear soon after the operation. The flushes were, for the most part, of the ordinary type, but about once a day the patient suffered a sensation of great pressure in the head, accompanied by nausea. The eyes became suffused and there was mental confusion with inability to articulate. After several of these attacks, which came on periodically, the patient became alarmed and consulted me. Ovarian residue was given, with complete relief of the more serious symptoms and almost complete disappearance of hot flushes.

In this case we must consider the possibility of error on the ground that there may have been a hysteric element in the symptoms and a psychic influence in the treatment. This possibility cannot be entirely ruled out, but the patient is unusually intelligent and sensible and has not exhibited the slightest sign of hysteria in any other way. I am convinced that in this case the extract exerted a specific action on the symptoms.

These three cases illustrate the treatment of postoperative menopause symptoms and are perhaps more interesting to the surgeon than to the general practitioner. Similar results may be obtained in the treatment of the natural menopause disturbances. It has been my experience, however, that in the latter cases ovarian therapy acts with less promptness and surety, but is nevertheless a valuable remedy.

To the general practitioner the question of the value of ovarian therapy in menstrual disturbances is, perhaps, of chief interest. Theoretically one would expect it to have a specific influence on the protracted functional amenorrheas, but unfortunately this is not the case. I have prescribed the treatment for many patients

with this trouble, but have met with a conspicuous number of failures. Nevertheless an occasional success has been encouraging and suggests that a greater knowledge of the properties of the active ovarian substance and a more accurate information as to the causes of amenorrhea may in time lead to more successful treatment. Thus it frequently happens in treating cases of protracted amenorrhea that the administration of ovarian substance is promptly followed by a menstrual flow, but that continued treatment is without further effect. Such a case must be recorded as a failure, yet the primary effect certainly suggests that the ultimate inability to establish a catamenial rhythm may be due to ignorance as to the best method of administering the ovarian substance. Some cases of functional amenorrhea do not respond at all to ovarian therapy, and this, in my experience, is especially true when stigmata of other glandular involvement are present. Affections of the hypophysis and thyroid are most commonly represented in the polyglandular type of amenorrhea, in which case extracts from the corresponding gland are indicated in conjunction with ovarian substance.

When the amenorrhea is incomplete, that is to say, when it is interrupted by an occasional catamenial flow, the prospect of establishing a normal menstrual rhythm is favorable, as is well illustrated by the following case:

A school girl of eighteen consulted me in 1913 for infrequent menses, which appeared at intervals of about four months, accompanied by severe dysmenorrhea. For two or three years the patient had suffered from a constant sense of pelvic pressure. The menses had become infrequent three years before and at the same time the patient had begun to accumulate fat. Aside from the tendency to adiposity there was no other special indication of a polyglandular affection. The uterus was small, but not markedly infantile. An extract of the whole ovarian gland was prescribed and the patient directed to report by letter after each menstrual period. The directions were carried out minutely, and in a few months a regular menstrual rhythm had been established with intermenstrual periods of six weeks. The dysmenorrhea had almost completely disappeared, while the pelvic press-

ure, which had before been constant, was entirely relieved. After about a year I heard no more from the patient until June, 1917, when she again came under my care for chronic appendicitis, for which she was operated upon. At this time she stated that for the past three years the menses had, for the most part, been regular, with six-week intervals, but that occasionally they would be delayed for two or three months if she paid no attention to them. She kept a quantity of the ovarian extract on hand which she was accustomed to take when the menses did not appear on time. Under these circumstances menstruation would invariably appear within a week. The uterus at the time of the appendix operation was normally developed and the distinctive adipose look of the patient had disappeared.

The chance for error in this case is that the patient underwent a natural development coincident with and independent of the treatment. On the other hand, the response was so prompt and distinctive and has been so constant up to the present time that we may reasonably conclude that the symptoms were specifically influenced by the ovarian substance.

A similar case in my records is that of a girl of nineteen whose mother consulted me in June, 1917, with the statement that her daughter had been suffering from delayed menses, the periods averaging nine to ten days late. The delay was associated with physical depression and headaches. No opportunity was given for a pelvic examination, and I can only say that the physical appearance of that of the adipose type was rather more marked than in the previous case. In this case the pregnant ovarian residue was prescribed, to be taken for the ten days preceding the date on which the menstrual period should fall. Menstruation appeared at the proper time after the first ten days' treatment. This course of treatment was successfully repeated for two or three months, when a normal rhythm seemed to be established, so that now at the end of six months the patient menstruates regularly without the aid of medicine. She is in perfect health, the menstrual molimina having disappeared. The chance of misinterpretation in this case is that the effect on the menses may have been psychic. It is true that mental influences may affect the

menstrual function, either to inhibit it or to bring it on prematurely. In my experience, however, any mental influence sufficient to create so marked a change as was produced in this case would necessarily be the result of some profound emotion and would have acted deleteriously rather than beneficially.

The next case is one of scanty menstruation and dysmenorrhea associated with general physical depression. The patient is a young woman of twenty-one who works for a living. She did not menstruate until she was eighteen. For a year previous to the time of consultation the menses had been scanty and painful. Examination showed the patient to be overweight, with a uterus in marked anteflexion. Ovarian residue was prescribed to be taken continuously. Monthly reports were to be made after each period. The case was followed for four months, during which time dysmenorrhea disappeared and the menstrual flow gradually increased in amount. At the last report the patient stated that she felt entirely well and that the medicine had acted as a tonic.

I have noted a definite tonic effect from ovarian therapy in only a few instances. Possibly in this case the result was only psychic, that is to say, the general constitutional improvement due to relief of the menstrual disturbance was ascribed by the patient directly to the capsules which she was taking.

A special form of dysmenorrhea is that associated with clotting of the menstrual blood. The pain experienced by these patients is spasmodic and seems to be caused by the passage of the clots through the internal os. Certain cases of this kind seem to be amenable to ovarian therapy. The cases to be selected for treatment are not of the menorrhagic type, but rather those in which the flow is deficient or, at least, not excessive. The following is an example:

A married woman of thirty-nine, upon whom a reconstructive gynecologic operation had been performed several years previously, began to have clotting at her periods, with dysmenorrhea, headaches, and digestive disturbances. After seven or eight months she sought advice. Ovarian residue was prescribed to be taken for ten days preceding each catamenia. For three successive months the patient has reported a marked lessening of

pain and clotting, with corresponding improvement in headaches and indigestion.

A similar case is that of a woman of thirty-two, married five years without children, who consulted me in October, 1917, for clotting and dysmenorrhea. The treatment was prescribed for her as in the preceding case. Two monthly reports from this patient announce almost complete relief from clots and pain.

In the employment of ovarian therapy I have always been skeptical as to its efficacy in the treatment of sterility. I have, therefore, used it only occasionally for this complaint, and always with the statement to the patient that I had little faith in its accomplishing the desired results. Two cases have, however, very recently come to my notice in which there is at least a suggestion that ovarian therapy may have been instrumental in bringing about a pregnancy. Neither case is entirely conclusive, but I will present them for what they are worth. The first is that of a Jewish woman who called on me in December, 1917, bringing a friend whom she wished me to treat for sterility. She requested that I prescribe the medicine that I had given her and which she said had been entirely successful. I had quite forgotten the case, but on looking up her record found that in 1913 I had operated on her for multiple small fibroids and intestinal adhesions two years after her marriage. In June, 1916, she consulted me for sterility. I told her then that she probably would never have children, but prescribed lutein tablets (Hynson & Westcott) as a placebo. The patient stated that she very soon became pregnant and had a miscarriage at three months. She immediately became pregnant again and bore a child in June, 1917.

The second case is that of a woman of twenty-nine, married four years, who in April, 1917, consulted me for sterility and irregular menses. She occasionally had periods of amenorrhea lasting three or four months. Since the age of puberty there had always been more or less delay in the menses. Examination showed no pelvic abnormality. This was an ideal case for ovarian therapy, and accordingly a prescription was given for extract of the whole ovary (Armour's) to be taken continuously three times

daily. I did not see the patient again until September 17, 1917, when she made the following statement: For two months she had neglected to have the prescription filled. Soon after a menstrual period, which occurred in July 9th, she had procured the capsules and taken them faithfully for about a month, when she began to have bearing-down pains in the pelvis. Thinking that they were due to the medicine, she ceased to take it. Of late she noticed an occasional slight brownish discharge. For a week she had had daily nausea. There had been no menstruation since July 9th. Examination showed the patient to be about two and a half months pregnant.

In both these cases it is entirely possible that the occurrence of pregnancy following the ingestion of ovarian substance was an independent coincidence. I am, inclined, however, to regard both patients as having been potentially fertile, and that the ovarian substance acted to supply some functional deficiency in the pelvic physiology, which up to the time of treatment had been enough to prevent conception.

The nature of the functional deficiency and the manner of action of the ovarian substance are, with our present knowledge, only matters for conjecture.

In addition to the types of cases favorable for ovarian therapy, of which the foregoing are examples, I have had success in treating a certain number of patients who suffer from local discomfort resulting from circulatory disturbances of the external genitalia. The various conditions found in this type of case are usually the result of the atrophic changes which take place after the natural or artificial menopause. They include furunculosis vulvæ, kraurosis, pruritus, senile vulvovaginitis, and the vague forms of vulvar discomfort for which no well-defined pathologic cause can be detected. Not all of these cases are amenable to treatment, and my records show failures equal in number to successes. Nevertheless, some of the results with ovarian treatment are sufficiently striking to convince me that with a greater chemical and technical knowledge of the ovarian substance this will in time be an important field for organotherapy.

The rational basis for treating these circulatory cases is a

result of animal experimentation, which has demonstrated that the ingestion of ovarian substance produces a local hyperemia of the external genitalia in castrated animals. The immediate local relief which some patients receive after taking ovarian extracts indicates that a similar reaction takes place in human beings.

A perusal of the cases which I have reported will show that I have used the ovarian substance in three forms: 1. Ovarian residue, a dried preparation from the ovaries of pregnant animals, with the corpus luteum excluded (Parke, Davis). This is also put up in ampule form for hypodermic use. 2. Extract of the whole ovary (Armour's). 3. Extract of corpus luteum (lutein tablets of Hynson & Wescott). These three preparations have been, so far as my present experience goes, the most efficacious. The respective therapeutic value of the three forms has, in general, proved to be in the order named. This conclusion arrived at in a somewhat haphazard way from clinical observations is, however, not without rational theoretic confirmation. There is scientific evidence to show that the chief source of the ovarian internal secretion is in the so-called interstitial cells. These cells have their origin in the connective-tissue envelope of the follicles, and are developed both in the process of follicle atresia and in corpus luteum formation. Hence preparations from the ovarian stroma alone and from the corpus luteum alone both possess therapeutic value. It is probable, however, that the interstitial cells of the atretic follicles are more active than are the analogous cells of the corpus luteum. Preparations of the whole ovary, therefore, presumably would be more efficacious than those from the corpus luteum. This fact has been repeatedly shown in my own experience and in that of many other observers. It would seem to be corroborated by the fact that the advocates of corpus luteum therapy recommend enormous doses of lutein extracts for results which can readily be acquired with comparatively small quantities of the whole ovary.

The use of the ovarian residue of pregnant animals was the result of personal experimentation. In a series of cases treated with the corpus luteum of pregnancy it was found that the

substance had a decided toxic effect. As a control to this observation a series of cases was treated with the residue of the pregnant ovarian substance after the corpus luteum had been enucleated. The results with this preparation were striking and in some cases brilliant, toxic symptoms being entirely absent. This somewhat accidental discovery receives the support of the interstitial cell theory of the ovarian secretion, for during pregnancy follicle atresia is especially active, and hence there is at that time an unusual elaboration of the interstitial cells. It is, therefore, not surprising that the residue of pregnant ovaries has proved the most valuable therapeutic agent of any form that up to the present time has personally been tried. In my work on the ovarian residue I am indebted to Dr. J. F. Grant for valuable co-operation and suggestions.

CLINIC OF DR. EDWIN A. LOCKE

BOSTON CITY HOSPITAL

OSTEITIS DEFORMANS WITH SARCOMA OF THE HUMERUS

x-Ray Appearances in the Bones; Course and Prognosis; Differential Diagnosis; Symptoms; Treatment.

October 18, 1917.

THE case which we are to discuss this morning is an unusually interesting one not only as regards the primary disease but also the complicating condition.

Mr. A., to whom the case was assigned in the wards, will give us a brief history.

The patient, W. S., a violinist aged sixty-two, entered the hospital October 8, 1917, complaining of a painful swelling of the right elbow of eighteen months' duration.

Family History.—Negative.

Personal History.—Always strong and well. No illness except the diseases of childhood until the present illness. Always a heavy smoker. Very moderate drinker. Denies venereal. In 1892 fell and broke left patella. Of late years increasing deafness, and occasionally moderate sensations of fluttering in the region of the heart. No other cardiac symptoms. No respiratory, gastric, or renal symptoms. Weight for thirty years 180 pounds, now 160.

Present Illness.—For the past eighteen months the patient has suffered from pain in the region of the right elbow. It began as a slight and variable tingling in the joint, later becoming burning, and finally stabbing and paroxysmal. For the past few months the pain has been of a dull character, but constant and very severe, worse with any motion of the elbow. At first confined to the joint region, latterly the pains have been

felt in the upper forearm and lower arm. Any motion at the elbow-joint has become less and less because of pain. No swelling was noted until about three months ago, since which time it has increased rapidly and has been considerably inflamed. The enlargement was first noted in the region of the olecranon.

Physical Examination.—A few moderately enlarged lymph-nodes in the anterior cervical region, not tender. The heart very slightly enlarged to the left; no murmurs; sounds of good quality; A_2 slightly accentuated. Peripheral arteries palpable and tortuous. Blood-pressure $\frac{130}{85}$. The right elbow is enlarged to about twice its normal size, with the greatest prominence posteriorly, slightly reddened over the outer portion where there is definite fluctuation. Very acute sensitiveness to pressure; the slightest passive motion gives intense pain.

Blood: Hemoglobin, 85 per cent. Red count, 4,320,000 per cubic millimeter. Leukocytes, 8400 per cubic millimeter. Wassermann test negative.

Urine normal except for slightest possible trace of albumin. Temperature, pulse, and respiration normal.

DR. LOCKE: Briefly stated, we have here a man of sixty-two years whose past history is negative and who during the past eighteen months has suffered from a slowly increasing and painful swelling of the right elbow. Your physical examination is negative except for the condition in the elbow and the evidence of arteriosclerosis. What conditions have you considered as explaining the swelling in the right arm?

Mr. A.: I have considered gout, chronic arthritis, Charcot's joint, tuberculosis, osteomyelitis, syphilitic arthritis, and malignant disease.

DR. LOCKE: Before discussing the diagnosis I want to show you the *x*-rays of the affected arm. The appearances are quite extraordinary. Note first that the humerus is fairly evenly enlarged to nearly twice its normal diameter, but the lime salts are strikingly lacking. The normal structure is almost entirely lost. The medullary portion is fairly marked; the cortex is unevenly striated, with here and there coarse trabeculæ.

At its distal end for a distance of about 3 inches the bone is

represented by a mere shell very much broadened, honeycombed, and irregular. There is hardly a semblance of a joint cavity. Likewise the structure of the epiphyseal portion of the radius and ulna present changes of exactly similar nature except that there seems to be little if any enlargement. The diaphysis of these two bones for a distance of 3 or 4 inches shows a marked degree of absorption, though the size is unchanged and considerable normal structure is preserved. The calcified arteries are plainly visible.

Will you now discuss the possible diagnoses which you mentioned?

Mr. A.: There is no evidence for gout either in the history or physical examination. The patient has had no symptoms suggesting this disease and I can find no tophi. The *x*-ray is negative so far as gout is concerned. Chronic arthritis seems more probable.

Dr. Locke: If this is chronic arthritis it must be one of two forms, namely, osteo-arthritis or infectious arthritis. So far as the former is concerned it would be very unusual to have an osteo-arthritis confined to an elbow-joint. It is much more common in the knee, hip, spine, or small bones of the feet and hands. Furthermore, the joint does not present any of the characteristics of this condition. Finally, the *x*-ray gives a picture entirely unlike osteo-arthritis.

So far as infectious arthritis is concerned it is sufficient to say that the patient has had no general symptoms of an infection, there are no heart complications, there is no evidence of a source of infection, and locally the signs of inflammation, except for pain, tenderness over a limited area, and slight redness over a small area of the surface, are wanting. The *x*-ray does not show the usual features of this type of joint disease.

Charcot's joint was the next condition mentioned.

Mr. A.: I believe this disease can be readily ruled out. There is no tabes, syringomyelia, or other chronic disease of the spinal cord here to which Charcot's joint is always secondary. The pain and tenderness are more extreme than is ever seen in this joint disease.

DR. LOCKE: The radiographs again give us valuable assistance. The *x*-ray appearances in Charcot's joint are very definite. Most characteristic of all is a degree of hypertrophy greater than is found in any other joint condition which I can recall. Not only does one see large excrescences on the bones forming the joint, but the capsule contains relatively large, free bodies which are densely calcified.

MR. A.: The advanced age of the patient is very much against the diagnosis of tuberculosis. There is no evidence of tuberculosis elsewhere in the body. With this disease there should be some fever reaction, the pain and acute tenderness would not be so extreme, and there are no sinuses which after a period of eighteen months might be present, and the roentgenograms do not show appearances characteristic of tuberculosis.

Osteomyelitis is likewise rare at this patient's age, there is no evident primary focus so commonly present, and fever is absent.

DR. LOCKE: Would you not expect a leukocytosis if this were a case of osteomyelitis?

MR. A.: Yes.

DR. LOCKE: There are no general symptoms of a localized infection. The *x*-ray appearances might conceivably be explained as resulting from an infectious process involving the bones and joint. Schuchardt describes an unusual chronic infection of the bones ("osteomyelitis centralis chronica") which is seen in mature years. If the focus in the long bone is near the joint the latter is often involved. It seems to me, however, that osteomyelitis may safely be excluded.

MR. A.: Syphilitic arthritis need not be discussed, as there is no history of a luetic infection and the patient shows no evidences of the disease. The Wassermann test is negative.

DR. LOCKE: Syphilis of the joints is a relatively rare affection, especially in the acquired form. In the tertiary stages joint complications occasionally develop, and, I believe, are almost never recognized as luetic. Two types occur: (1) The so-called "perisynovial gummatous arthritis" usually affecting the knee-joint, but occasionally the elbow, the periarticular tissue being invaded by gummatous deposits. It may simulate closely joint

tuberculosis. (2) A rarer form, which is really an osteo-arthritis, is also most common in the knee. The resulting enlargement of the bones may be mistaken for osteosarcoma.

What form of malignant disease had you in mind?

MR. A.: Primary carcinoma of the bone is very rare, and secondary carcinoma can be discarded, as there is no primary focus which after so long a period would be evident. If the tumor is a malignant growth I had considered it a sarcoma of some form. Its gradual growth with increasing pain and loss of function of the joint is characteristic of sarcoma. The general appearance of the tumor is typical also.

DR. LOCKE: I should consider the extensive destructive process in the bones and joint as indicated by the roentgenograms as typical of what is often seen in sarcoma. It seems to me the most probable diagnosis is sarcoma of the humerus.

Close observation should have led you to note certain other appearances in this patient which are very obvious and which are pathognomonic of another disease. The malady is a very common one and so striking in the deformities which it invariably presents that it cannot be overlooked. It is my experience that the condition is but seldom recognized. Did you notice any deformities?

MR. A.: His legs are somewhat bowed, but I thought it was due to old age.

DR. LOCKE: Yes, the legs are evenly and markedly bowed throughout, the curve being outward and forward. The bowing is perhaps more noticeable in the lower legs than in the thighs. Palpation of the thighs indicates a considerable thickening of the femora and they are much curved. The tibiæ are enormous, being at least twice their normal size, almost cylindric, and their surface very uneven, the normal markings being entirely lost. The left shows greater changes than the right. Both knees are very massive, but motion is reasonably free. There are no objective signs of inflammation. The feet and ankles are not noticeably abnormal. The pelvis is extremely broad, and if you will examine the bones you will see that they are very massive and irregular.

As I test the motion in his spine you will see that it is almost rigid throughout. The lumbar portion has lost entirely its normal curve and the dorsal presents a very definite kyphosis.

The chest may at first glance not strike you as unusual. Look, however, at its general shape. It is unusually deep, but not only is the anterior posterior diameter increased but the thorax looks as though it had been compressed laterally. It is actually quadrilateral, in sharp contrast to the rounded chest seen in emphysema. If you will examine the bones of the thorax you will find that they are all significantly augmented in size. If I ask the patient to take a deep breath it will be evident that the breathing is diaphragmatic in type, the ribs scarcely moving as in normal respiration.

The normal curves of the clavicles are grossly accentuated and they are much enlarged and rounded. Equally great changes and of the same nature are to be found in the scapulæ. This patient fails to show what is so striking in many, namely, an appearance as though the head were set almost directly on the shoulder girdle. In some the chin is carried forward and practically rests on the sternum, from which it can be raised only an inch or two.

I am able to demonstrate more than the usual alterations in the bones of his upper extremities. The deformities are about equal on the two sides. The humeri are bowed anteriorly throughout their entire length, and as I feel them it is evident that they are much larger than normal. The bones of the forearms do not feel enlarged, but you will clearly see a considerable outward bending. Pronation is complete, but supination is greatly limited. The hands appear unchanged.

The calvarium looks a trifle larger than normal, but the measurements made in the ward are within normal limits. You will all agree that the lower jaw is very large and projects forward (prognathism).

If I now have the patient stand, many of these changes will be emphasized. It also gives me an opportunity of calling your attention to certain important characteristics of the disease. In the first place you will observe that the posture is quite unique.

He stands with the feet strongly everted, so that they are at about a right angle and with one considerably in advance of the other. This position of the feet is presumably taken in order to preserve a proper balance. The bowing of the legs is much more evident in the standing position. The internal condyles are about 20 cm. apart. Marked flexion of the pelvis on the thighs throws the trunk forward, which, together with the forward curving of the spine, gives a striking stooping posture.

Particularly noticeable is the contraction of the abdomen. It is small and protruding with a deep transverse groove at the level of the navel due to the fact that the costal edge is almost resting on the crests of the ilia. In consequence of the forward position of the trunk the arms appear unusually long, the hands reaching to the knees. This suggests the semblance of an anthropoid ape so often mentioned.

The patient's gait as you see him walk is peculiarly stiff and waddling. With each step the pelvis is tilted and the leg swung forward.

Considering the changes which I have just demonstrated in the skeleton I feel sure it will be possible to elicit from the patient some further history bearing on these changes.

(Addressing patient): Your legs are considerably bowed. Have you not noticed this before entrance to the hospital?

PATIENT: About eleven years ago my son called my attention to the fact that my legs were slightly bowed, and for several years following I think the deformities increased somewhat, but for the past eight or nine years I am sure no further changes have taken place. The left has always been more deformed than the right. The condition, however, has never bothered me and I have paid very little attention to it.

DR. LOCKE: Have you noted any changes of a similar nature in the thighs or pelvis?

PATIENT: I am sure no changes have taken place.

DR. LOCKE: Have you had any pains in the legs?

PATIENT: Not in recent years. Some years ago I occasionally had dull and rather severe pain in the lower legs which seemed to be in the bones.

DR. LOCKE: Have you ever had any localized swelling or redness over the bones of the lower legs, or has there been any tenderness?

PATIENT: No, but if I injure my shin in any way it seems unusually sore and for a long time.

DR. LOCKE: Have you ever had cramps in your legs?

PATIENT: Not in recent years, but some six or eight years ago I frequently had very severe agonizing cramps in the calves of my legs after going to bed at night.

DR. LOCKE: Have you any opinion as to the cause of these cramps?

PATIENT: They usually came on at night after I had been on my feet all day and was very tired.

DR. LOCKE: Were these cramps severe?

PATIENT: At times they were very severe, forcing me to bound out of bed. I could get some relief from rubbing the muscles, but more from walking about on the cold floor.

DR. LOCKE: Have you noticed any difference in your gait or stiffness in your joints?

PATIENT: I can walk about as usual, although I am perhaps a little more clumsy and stiff. The joints all over my body are occasionally stiff also, but I have attributed this to my age.

DR. LOCKE: Have you lost any height?

PATIENT: I do not think so. I cannot recall exactly my former height.

DR. LOCKE: It is obvious that from the patient's position in standing he must have lost at least 2 or 3 inches. (To patient): Have you been obliged to increase the size of your hat in the past ten or fifteen years?

PATIENT: No, I wear the same sized hat now as when a young man, namely, $6\frac{7}{8}$.

DR. LOCKE: Have you noted any change in the lower jaw?

PATIENT: Yes, for many years I have noticed that the lower jaw was somewhat more prominent, and my family have called my attention to it.

DR. LOCKE: I have taken the time to ask these questions before you because it illustrates so characteristically the insidious

course of the disease. The changes in the skeleton are so gradual and often without pain that the patient is entirely unconscious of them until an extreme stage of the disease is reached. During the past fifteen years I have had the opportunity of examining a considerable number of these cases, and in almost every instance the characteristic changes have been first noted by some member of the family who has called the patient's attention to them.

x-RAY APPEARANCES IN THE BONES

I shall now show you roentgenograms of the entire skeleton, calling your attention to the type of changes manifested. First, let us take a lateral *x*-ray of the skull. The appearances shown are most surprising and striking. You will see first that there is an enormous thickening of the entire calvarium, the bone in its thickest part, which is in the occipital region, being fully ¾ inch. Although the surface is somewhat uneven the bone is, on the whole, of fairly uniform thickness. In contrast to the normal skull as shown in the *x*-ray you will see that its structure is entirely changed. The inner half is perhaps more dense than normal, but the outer portion is thin and shows an entirely abnormal appearance. At the very cortex the calcium salts are in places entirely wanting. In no part, however, is the bone substance entirely absent over large areas, as is so characteristic of the appearances seen in syphilis and certain of the tumors.

So far as the remainder of the skull is concerned you will see that everywhere the bone seems to be increased in density and appears massive. This is equally true of the interior maxillary bone.

Next let us take the tibiæ, which show most extraordinary appearances. In the first place you will see that the entire bone is involved, the changes being almost equally evident in all parts. Second, the bone in each case shows a broad curve throughout. Third, the bones are enormously thickened, in case of the left to nearly twice the normal diameter. Fourth, the normal markings which differentiate the medulla from the cortex have to a great extent disappeared. Fifth, the thickening appears to be greatest on the convex surface. Sixth, the outline

of the bone is especially on the convex surface particularly irregular and wavy. Seventh, the minute structure of the bone appears absolutely abnormal, scarcely any of the normal markings being present. In places, especially at the cortex, the bone seems thin and evidently contains very little lime salts, while in other places the density seems to be increased. Eighth, in the epiphyseal

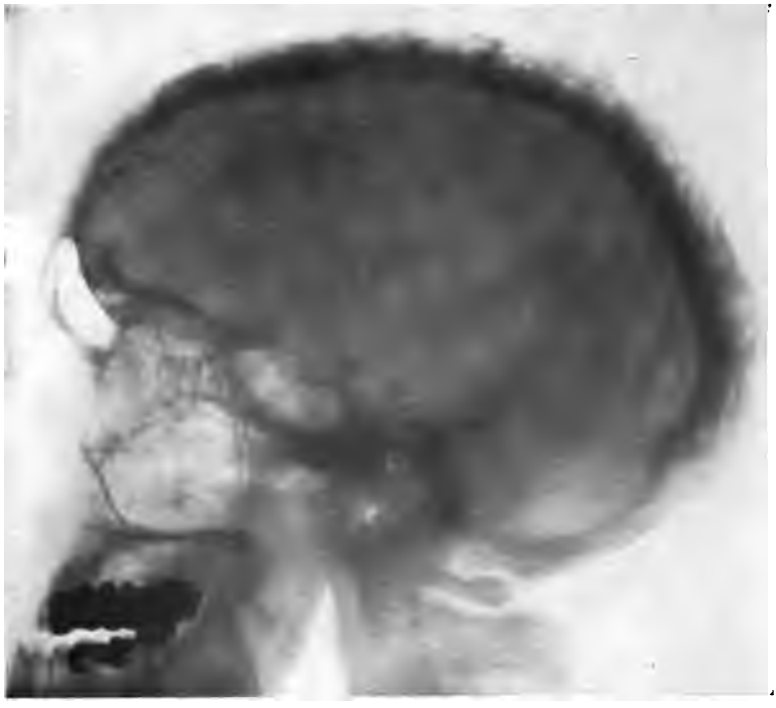

Fig. 99.—Lateral view of skull. Note the general increase in the osseous structures, especially the great thickening of the calvarium and the alterations in the outer table.

portion the bone seems very much increased in size and the internal markings altered strikingly. There is very coarse trabecular marking. The articular surface seems to be unaffected. In a few places you see small oval areas lying lengthwise in the shaft of the bones from 1 to 2 cm. in length which represent small bone cysts. These are quite commonly found in this disease.

On looking at these *x*-rays one is immediately struck with the

clearness with which the arteries of the legs are seen. They appear very tortuous, and from the clearness with which they are seen it is fair to assume that they are extensively calcified. I shall call your attention to this same condition in the *x*-ray of the thighs and arms.

Fig. 100.—*x*-Ray of tumor of left elbow. The humerus is thickened to twice its normal size, and in its distal portion the bone is almost completely destroyed. Hardly any normal joint muscles remain.

The fibulæ are not well shown in these *x*-rays, but it is clear that the involvement of these bones, although of the same type, is much less extensive and marked. The patellæ show considerable change.

If we now examine the bones of the feet we observe rather general changes of the type described above in the os calcis and astragalus in each foot, and also in one or two of the tarsal bones. Alterations of about the same grade as exist in the right tibia are

Fig. 101.—Case shown in clinic. Note characteristics described in text.

evident in the femora. I am sure you are surprised by the appearances of the bones of the pelvis. Not only is the internal structure entirely altered, but the bone everywhere seems greatly thickened. Even in the vertebræ one finds evidences of moderate changes.

The thorax likewise shows unmistakable variations from the normal. A few of the ribs are noticeably gross, and in places the structure of the bones is quite similar to that described in the tibiæ. The most marked changes are seen in the clavicles and scapulæ. Even more marked are those in the humeri, both of which are nearly twice the normal thickness and are moderately curved anteriorly. The bones of the lower arm are only slightly changed, while those of the hand are normal except for one or two of the carpal row.

DISCUSSION

We have before us, then, a patient whose history, general skeletal deformities, and the *x*-ray appearances of the bones are very typical of osteitis deformans (Paget's disease). I will give you references to a few of the best general articles on the subject:

Paget: Med.-Chirurg. Trans. Med. Chirurg. Soc., London, 2d series, vol. xlii, 1876, p. 38.

Sternberg: Nothnagel's Specielle Pathologie u. Therapie, Bd. 7, T. 2, Abt. 2, s. 64, 1899.

Packard, Steele, and Kirkbride: Amer. Jour. Med. Sci., cxxii, 559, 1901, and Trans. Assoc. Amer. Phys., xvi, p. 666.

Schirmer: Centralblatt f. d. Grenzgebiete d. Med. u. Chir., Bd. 11, Nos. 15-19.

DaCosta, Funk, Bergeim, and Hawk: Publications from The Jefferson Medical College and Hospital, vol. vi, 1915, p. 1.

The term "osteitis deformans" was first suggested by Czerny in 1873. The condition described under this name was a local inflammatory process confined to the lower portion of one tibia and fibula in a young man of twenty-two. From the description of the case given by Czerny it is clear that the condition which he describes is entirely different from the disease now commonly known by that name.

A few years later, namely, in 1876, Paget reported before the Medico-Chirurgical Society of London a series of 5 cases under the title, "On a Form of Chronic Inflammation of Bones (Osteitis Deformans)." This paper is one of the classics in medicine and I would strongly advise all of you to read it. It is quite remarkable for the accuracy in observation and the masterly description of the diseased condition. It is fair to say that the history of the

Fig. 102.—Right radius and ulna. Ulna normal. Radius shows typical bowing and alterations in structure throughout the diaphysis. Articular surfaces unchanged.

disease begins with this paper by Sir James Paget. Thirteen years later this same author stated that he had subsequently seen 18 cases, making a total of 23. Since this time a voluminous literature on the subject has accumulated, but notwithstanding the many studies made, surprisingly little has been added to the original description by Paget.

Incidence: The original statement of Paget that the disease is a rare one would seem to be borne out by the fact that to date approximately only 250 cases have appeared in the literature. Hurwitz found only 3 cases among 30,000 medical admissions to the Johns Hopkins Hospital, and DaCosta, Funk, Bergeim, and Hawk only 3 cases among 38,000 admissions to the new Jefferson Hospital in Philadelphia. I cannot agree, however, that the condition is so rare as these figures might indicate, for my own experience includes nearly 50 personally observed cases. Each year several are seen in the wards of this hospital.

Etiology. — Many theories have from time to time been ad-

Fig. 103.—Lower legs. In left tibia observe the bowing and immense thickening throughout, complete alteration in structure; wavy indistinct outline along anterior surface, indistinct outline of medulla, and cyst formation. Right tibia shows earlier changes of the same type.

vanced to explain the origin of this disease. Among these causes are gout, chronic rheumatism, syphilis, trauma, neurotrophic condition, disturbance of the secretion in the ductless glands, and bacterial infection. Positive proof is uniformly lacking that any one of these is the cause of the changes in the bones, and I believe it can be reasonably stated that the etiology is unknown. In my own series of cases I have been particularly struck with the fact that they have uniformly shown an extreme degree of arteriosclerosis which I can hardly conceive as appearing in so large a series without some etiologic significance. Your attention was called to the high degree of sclerosis in the arteries of the arms and legs of this patient as indicated in the *x*-ray plates. It is my conviction that the disease is in some way dependent upon trophic changes which result from extreme arteriosclerosis.

Osteitis deformans is usually spoken of as a disease of old age, but a study of the cases in the literature indicates that in a majority of instances it begins in early middle life. Several instances of cases beginning under twenty have recently been recorded. Its course is usually a very long one, frequently covering thirty or forty years, and as the patient usually comes under observation only when the disease is well developed, which frequently means after a period of from ten to twenty years, it is easy to appreciate that the impression should be given of a disease of old age.

Heredity seems to play a very definite part. A considerable number of instances are now recorded where a member of the previous generation suffered from the same malady. Among the cases which I have observed approximately 20 per cent. give a history of the same condition having existed in one of their parents.

Males seem to be about twice as frequently afflicted as females.

Pathology.—The essential changes taking place in the bones may be summarized as follows:

1. The process usually begins in the long bones of the lower legs, although not infrequently its first appearance is in the skull. In the late stages of the disease practically the whole skeleton may be involved.

2. The individual affected bones are much enlarged, and in the case of the long bones are more or less cylindric and show the process evenly distributed throughout the entire shaft. In a few instances individual bones are seen in the *x*-ray where the changes are confined to a third or more of the bone, giving the appearance as though the shaft were gradually being invaded. The surface is slightly rough and uneven, but never shows large exostoses.

3. Bowing of the entire shaft of the long bones is marked and characteristic.

4. For the most part the bones are soft and cut easily with a knife, although in certain areas and especially in the late stages of the disease one finds areas of ivory hardness.

5. The cut surface shows a coarse, trabecular structure alternating with large and small areas of denser bone tissue. When the process is well advanced the normal appearance of the cut surface is entirely lost. The bones seem very rich in blood.

6. The marrow space is early encroached on and frequently entirely obliterated.

7. The periosteum is not, as a rule, thickened, but is often slightly adherent.

8. Small cysts are frequently seen.

9. The articular cartilages are, as a rule, preserved and caries and necroses are never present.

The process going on in the bones is a double one. First, there is a resorption of old bone; second, an apposition of new "fibro-osseous" tissue. From *x*-ray studies of cases over a long period of years it seems evident to me that the two processes go hand in hand, although probably the resorption of old bone is the initial one. The apposition of new bone takes place largely from the periosteum, although the marrow contributes also.

Careful chemical analyses of various bones in 4 of my cases have given somewhat varying results which are difficult to interpret. These analyses have all shown a great increase in the percentage of organic matter with a marked diminution in the percentage of lime and magnesium and a slight decrease in the percentage of phosphorus. The only trustworthy metabolism ex-

periments are those recorded by DaCosta, Funk, Bergeim, and Hawk (2 cases). They find a pronounced detention of calcium, magnesium, and phosphorus, with a pronounced loss of sulphur, which findings they interpret as indicating a stimulated osseous or osteoid formation accompanying the resorption of the highly sulphurized organic matrix.

Symptomatology.—The disease shows quite extreme variations both in the rapidity of its development and its clinical manifestations, but, on the whole, the clinical picture is one of unusual definiteness. Only in its early stages should the disease ever be confused with any other condition.

The roentgenograms particularly show structural changes, deformities, and an order of involvement of the bones which is unique.

The onset is invariably insidious, the patient being unable to give exact statement as to the duration. As a rule neither

Fig. 104.—Reproduction of a tibia of an advanced case of osteitis deformans. Compare with *x*-ray of tibia (Fig. 103). The bone is involved in its upper two-thirds only, the line of demarcation between the diseased and normal bone being well defined. In the diseased portion the striking features are the enormous thickening, greater in the anterior portion, and with alterations in structure, the slight anterior bowing, and the increase in blood.

pain nor deformity is the first symptom noted. In a vast majority of cases the first signs observed are objective and consist in a bowing of the lower legs. The process which so often begins in the tibiæ gradually involves the rest of the skeleton almost always in a manner which may be called irregularly symmetric. In a few cases given in the literature alterations in the calvarium seem to antedate by a considerable period, often years, those in other parts of the skeleton (hyperostosis cranii). In a vast majority of cases, however, where the process is well developed the axial bones are the ones most involved. *x*-Ray studies of cases of osteitis deformans demonstrate clearly that the process may begin in several bones at the same time. The characteristic bowing of the long bones is admirably illustrated by the case which you have seen today. The arching is always in the direction of the natural curve of the bone.

The attitude of a case of osteitis deformans on standing I have demonstrated to you this morning in considerable detail. You have seen that it is both unique and grotesque. So characteristic is it that in well-developed cases inspection is quite sufficient for diagnosis. The head is, as a rule, enormous, the enlargement being confined largely to the calvarium. It is frequently carried forward with the chin almost touching the chest. The small quadrilateral thorax is held rigidly during respiration and the bones seem massive. The spine is curved forward, bringing the costal border almost in contact with the crests of the ilia. The abdomen is, in consequence, small and protruding, and usually with a deep transverse groove. In contrast to the relatively small trunk the pelvis is enormously widened and seems out of all proportion to the rest of the body. The legs are bowed outward and forward and in extreme cases are actually crossed. On standing, the feet are everted to approximately an angle of 90 degrees, and there is a considerable degree of flexion in the hip-joints, knees, and ankles. Although much less frequently seen, the arms may also present quite marked changes, the upper arms being curved forward and the forearms outward and forward. The gait, as you have seen, is strangely labored and waddling.

Pain, which is present in a considerable majority of cases, is a most annoying symptom. As it coincides with the seat of bone changes it is most common in the legs, although I have frequently seen it in the arms and back. The character of the pain is variable. Most commonly it is described as an intense, dull, rheumatic pain which seems to be in the bones. Occasionally it is sharp and lancinating. An individual with osteitis deformans may reach an advanced stage without any pain whatsoever. With the vast majority the intensity of the pain diminishes materially with the advance of the process in the bones. Intense cramps in the muscles of the lower legs are common.

I have observed very constantly in these cases general failing health, and they frequently present the picture of premature senility. Although the joints are seldom involved in the sense of any actual arthritis being present, patients very frequently complain that all their joints are stiff.

Undoubtedly a *mono-osteitic form* of this disease occurs, although it must be considered an excessively rare condition. Dr. Hurwitz, of the Peter Bent Brigham Hospital, has recently published an excellent paper on this subject reporting one of his own and collecting others from the literature. No case of this type should be accepted as an example of Paget's disease unless the diagnosis is confirmed by histologic or radiographic examination, for the condition may be easily confused with syphilis or malignant growth of a bone. Several cases which were apparently the mono-osteitic form have come to my notice. In each instance radiographs of the entire skeleton have shown typical osteitis in multiple bone.

Complications are not a striking feature of this disease. Occasionally I have seen severe neuralgia develop, but with no greater frequency than in the case of other chronic debilitating diseases. Cardiovascular changes are perhaps most commonly associated with the condition. The frequency with which a high degree of arteriosclerosis occurs has already been emphasized. Undoubtedly as a result of this condition myocarditis is frequently found. In the late stages of the disease cardiac dilatation is so common as to be almost considered the rule.

Fractures of the affected bone are far less common than in osteomalacia, a fact entirely in accord with the striking difference in the process in the two diseases. Surprisingly few examples of fracture are found in the literature of this subject. Among my own cases I have seen a considerable number, usually of the tibia, femur, or long bone of the arm. The explanation of the fact that fractures of the diseased bones do not occur more frequently is explained by the extensive formation of the so-called "fibro-osseous tissue" which plays such an important part in the pathology of the disease. I have personally seen some eight or ten examples of fractures, usually spontaneous, in patients suffering from osteitis deformans, and in each instance the bone has healed promptly and completely. Indeed, in a few cases the healing has seemed even more prompt than in the case of normal bone. Although the disease itself practically never involves the joints, a moderate degree of osteo-arthritis, especially in the knee, hip, or elbow, is a fairly frequent accompaniment. Localized periostitis, usually of the tibia, is very frequently met with. Insanity has been recorded in a few cases. Paget himself emphasized the frequency with which malignant disease either of the bone or other tissues complicates osteitis—8 of his own cases were traced to the end, and 5 died of malignant disease. Many other examples of such an association are recorded. It would seem reasonable that sarcomatous growths should develop in the bone where, as a result of the extraordinary changes, the normal cellular activity must be greatly disturbed.

Course and Prognosis.—The course of the disease is, as a rule, very protracted, ranging from ten to forty years. The activity of the process in the bones very often seems to become quiescent after a period of ten or twenty years. I can recall several instances where the disease has not appeared to progress during a period of ten or twelve years and where the *x*-rays have failed to show any progress in the alteration. Death never results from the osteitis, but from some intercurrent disease, most frequently of the cardiovascular system.

Differential Diagnosis.—This seldom if ever presents any difficulties unless it be in the very early stages of osteitis defor-

mans when the characteristics of the disease are not fully developed.

Localized hyperostoses may rarely be confused with Paget's disease, especially those of luetic origin. Hyperostosis affects only a portion of a single bone, most often giving it a spindle shape locally, but not deforming the entire bone as in the case of Paget's disease. The *x*-ray indicates a periosteal growth, usually a spindle-shaped enlargement of the bone, and, so far as the finer structure is concerned, only an increase in the normal structures or increased density.

Rickets possesses only the most superficial resemblance to osteitis deformans. The former is a disease of growing bones in early life. It is not progressive and the osseous changes are not so general. The process affects the epiphyseal portions particularly, which are short and small, and the curve unlike osteitis deformans. The *x*-ray appearances in the two conditions are entirely dissimilar.

Osteomalacia under some circumstances presents a picture more closely resembling osteitis deformans than any other condition. Osteomalacia occurs most commonly in young women, especially after childbirth. Spontaneous fractures are more common. Anatomically the changes in the bones are quite unlike those found in osteitis. The bones are thin and show a marked process of atrophy. The bowing is angular and irregular, as is also the enlargement when present. In the case of this disease the process in the bones is essentially one of decalcification, whereas in osteitis deformans the predominant process is one of new bone formation with an actual deposit of lime salt.

Osteoporosis senilis need hardly be mentioned. Here there is no hypertrophy of bone, but rather an atrophy and deformity occurs only as a result of fracture and callous formation. Pain is wanting.

Secondary hypertrophic osteo-arthropathy (ostéoarthropathie hypertrophiante pneumique, Mariés) in its later stages may, as in one example which I recall, show changes in the long bones not unlike osteitis deformans. In this instance the bones were enormously thickened and the finer structure as shown in the

x-ray was very suggestive of osteitis deformans. The bones, however, were not curved. Except in these late stages the process in the long bones is strictly confined to the cortex, the new bone being laid down as a definite layer just beneath the periosteum. The clubbing of the fingers and toes and the cylindric enlargement of the lower legs and forearms are signs which in themselves are sufficient to establish a diagnosis of osteo-arthropathy as against osteitis deformans.

Therapy.—There is no specific treatment.

NOTE.—The patient left the hospital on October 21st and on November 23d he entered the Peter Bent Brigham Hospital on the service of Dr. John Homans, 2d. During the interval the tumor had increased considerably in size and the symptoms were more severe. A diagnosis of sarcoma of the humerus was made by Dr. Homans, who operated December 12th, amputating the arm and resecting the axilla. The tumor on section was found to be a new growth of the femur, the central portion having broken down and being filled with a bloody fluid. Histologic examination showed the structure typical of spindle-celled sarcoma (Dr. Wolbach).

CLINIC OF DR. CHARLES J. WHITE

HARVARD MEDICAL SCHOOL

PREMATURE LOSS OF HAIR

Infectious Diseases; Diagnoses; Effects of Systemic Toxemias on the Scalp; x-Ray Alopecia; Hygiene of the Hair; Management and Treatment of the Different Varieties of Alopecia, etc.

GENTLEMEN: It has been said from time to time by various other specialists in medicine that dermatologists often write upon trivial themes. This may be true at times from the viewpoint of physicians who are not interested in scientific cutaneous medicine; but I assure you that there are many clinical themes which may seem of slight importance to a man in his capacity as an operating surgeon, for instance, but let that same man be affected by certain skin diseases and he will often quickly change his mind and come running to the dermatologist for help and advice. Such an assertion I base on repeated experience. Such a theme is premature loss of hair, a loss which may result from an infectious disease, from alopecia areata, from the application of *x*-rays, but principally from the combination of heredity and subsequent infection with the germ of seborrhea.

Infectious Diseases.—If an individual acquires an infectious disease, be it pneumonia, scarlatina, measles, or what not, he frequently notes a subsequent loss of hair which is usually generalized in distribution and may be slight in amount or may be of such a degree as to alarm his peace of mind. There does not seem to be any hard-and-fast rule in the frequency of this alopecia, but let me state that it occurs, fortunately, in the decided minority of instances. There is, however, a strikingly correct observance of the interval of time elapsing between the onset

of the fever of the disease and the subsequent initial loss of hair. One might even say that one could tell a patient the exact date of the incidence of his previous constitutional symptoms if one were told the precise day on which the hair began to fall. This interim is practically three months.

In this connection allow me to relate a curious illustration of this phenomenon. A young girl was attacked by erysipelas of the scalp which in the course of the disease involved the anterior half of the head. A few days after the subsidence of the infection the hairs began to fall from the involved portion of the scalp and eventually practically totally disappeared; but three months from the time when she fell ill the hair began to disappear from the remaining portions of the head. Here we had the rare opportunity of observing the local as well as the constitutional effects of a toxin.

This local effect of infection is, of course, best observed in cases of alopecia due to infection with the ringworm and favic organisms, *i. e.*, Tinea tricophytina and Tinea favosa; but here the loss of hair is due not to toxins, but to the actual consumption of the hair by the plants. In ringworm two varieties of hyphomycetes are observed, the microsporon and the megalosporon. In the former only children up to the age of fourteen are affected and the result is one or more sharply bounded, rounded areas of apparent baldness in which one observes the scalp covered with ashen gray scales from which emerge a relatively small number of hairs perhaps $\frac{1}{8}$ inch in length. If one pulls out one of these hairs and holds it up to the light one will note its apparent increase in diameter due to the surrounding envelope of plant growth. In the baldness due to the large-spored variety all ages may be affected, but in Boston this type exists in not more than 10 per cent. of the cases. Here the area is ill-defined and of irregular shape. The scalp is reddened and the overlying scales are few in number. There are no broken-off hairs and islands of perfectly normal hairs may persist in the midst of the affected areas. In favus the loss of hair does not occur in any prescribed localized patch—it is totally irregular, it has no definite shape. One sees merely the absence of hairs, a

yellowish, adherent, sparse scaling and a darkly reddened skin. Occasionally one can note the circumpilar, saucer-shaped yellow disk, called the scutulum; and, finally, if one will scrape away this scutulum or any other adherent scales, one will find a raw, bleeding surface. Fortunately, this disease arises but seldom in the New England states. We see numerous instances of this infection in our hospital clinics, usually in the eastern European, almost always in the Russian Jew who has evaded the vigilance of the immigrant medical inspector. In this disease there is not only an alopecia (which is permanent) but also an insidious destruction of the skin and its adnexa, so that in the neglected and untreated cases the end-result is a thin, cigarette-paper-like scar tissue covering the skull, all else is gone.

In these two diseases, ringworm and favus, the hesitating observer may clinch his doubtful diagnosis by a microscopic examination. Remove a hair or a scale from the affected area, but choose the hair in preference if a diseased hair can be found. Place this material on a slide and pour several drops of ether upon it to remove the confusing fat drops. Add KOH in 40 per cent. strength to dissolve the keratin and render the object more translucent. Apply the cover-glass and examine under a high, dry lens with the transmitted light largely excluded. The typical mycelium and spores reveal the true nature of the process.

To return a moment to the effects of systemic toxemias on the scalp. With two notable exceptions the lost hairs are so evenly distributed that we never note any sense of bald areas; one hair in every twenty, one hair in every ten or less, disappears and we observe a slight or marked general thinning of the hair, nothing more. As a rule, severe alopecia, subsequent to infectious diseases, is fortunately rare and the chances of return are generally most favorable. The two prominent exceptions to the above rule of thinning are in syphilis and in alopecia areata.

In syphilis we meet this focal loss of hair, and we look for it first of all above the ears, and from these two points this phenomenon extends gradually backward and upward, and if the dis-

ease continues untreated or unchecked the process involves the whole scalp even to complete baldness, but such a contingency is exceedingly rare; and let me state in passing that syphilitic alopecia is by far the exception and not the rule, contrary to popular belief. There is a probable reason for this focal alopecia in syphilis. In most of our infectious diseases we are dealing with a general, one might say distant, and not localized toxemia; in syphilis, on the other hand, we have, to be sure, the usual general poisoning of the infectious process, but we have also the focal toxemia. The spirochetes of early syphilis are borne by the blood-vessels probably to all parts of the body, and therefore to the scalp. We know from our knowledge of anatomy that the finer arteries of the skin project at regular intervals vertically upward to the free surface like the trunks of a tree, and then, like its branches, spread out on the surface in the form of capillaries in a circular arrangement. Such a structural arrangement would seem to explain the localized, more or less circular depilating action of the syphilis virus and its toxins.

In *alopecia areata* we have a second type of definitely localized baldness. Here one must hesitate in stating too explicitly that the cause of this disease is a toxin. At least ten years ago Jacquet, of Paris, drew our attention to the frequent concomitance of ulcerating teeth and alopecia areata and he must have been one of the first medical men to suggest the rôle of focal pus as a cause for distant, subsequent, pathologic processes. Be that as it may, one must today appreciate the fact that many individuals affected with this form of patchy loss of hair are likewise suffering from abscesses in their teeth. On the other hand, careful observers have noted too frequently in these patients the history of nervous shock to be able to ignore the fact that such a factor may play an etiologic rôle in at least certain of our cases.

The diagnosis of alopecia areata is a very easy one. Suddenly or gradually the victim notices a single bald area on the scalp or in the beard. Slowly or rapidly, as the case may be, this area increases in size and simultaneously one or more similar

patches may develop. This is all, and the now worried patient comes to us and we note the patchy loss of hair. The diagnostic feature of the case is that there is no redness of the scalp, no scaliness, no infiltration, no papulation, no subjective symptoms —just one or more, single or multiple, discrete or coalescent, round or oval, small or large, totally bald areas. But let us look once more before stating finally or too categorically that the patch is totally bald, for around the periphery we may note one or more peculiarly formed hairs of larger diameter distally than proximally, the so-called pathognomonic exclamation-point hair. The disease with or without the best of care may progress locally until total baldness of the scalp and beard may result; the eyebrows and eyelashes may share in the general defluvium; and in the end the patient may stand before us a hairless being. Such a fate bodes ill for the future, but experience has led us to believe that if eyebrows and lashes persist the patient will eventually regain his normal appearance.

The *loss of hair from exposure to x-rays* is naturally a phenomenon relatively new in our experience, but it is a condition which we as practitioners must appreciate and recognize and a contingency which the radiologists must always bear in mind and guard against. Nowadays not many weeks elapse in which the busy dermatologist is not confronted with this new entity, and he must not make mistakes, for this condition is increasing in frequency almost *pari passu* with the ever-widening scope of *x*-ray investigations. Approximately ten days after the improperly or insufficiently screened exposure the hair begins to fall and continues to fall in proportion to the susceptibility of the patient and to the length or the frequency of the exposures up to a maximum total loss. In the still more severe cases there may be not only alopecia but also erythema and even vesiculation, but these conditions are now, fortunately, growing to be less commonly observed. One may well ask how to differentiate this type of alopecia from other forms, and especially from that of alopecia areata. The loss of hair following *x*-radiation is apt to be of somewhat large extent, it is apt to be definitely on one or both sides of the head or directly anterior or unquestionably posterior,

unless, of course, this loss of hair was intentional, for at the present moment skilled dermatologists are making use of this depilating power of the rays to produce the fall of hair in cases of ringworm and favus, thus depriving these plants of their principal food supply and consequently causing their rapid death and disappearance. In such circumstances the loss of hair is patchy. In both of these contingencies, however, the suspicious observer could make the proper inquiries, learn the truth, and clear up the mystery. We must also be on our guard about confusing *x*-ray alopecia with that due to syphilis. Last year a physician consulted me on account of a marked loss of hair over the occipital region. He said with some heat that he was ashamed and exasperated by the furtive looks with which some of his colleagues regarded his head and with the open tauntings of others who asked him where he "got caught." To one familiar with the exact nature of syphilitic alopecia such suspicions and accusations would have been impossible, but as yet the knowledge of *x*-ray alopecia has not filtered down to all members of the medical profession, and, of course, has not come to the ear of the laity to any great extent. The truth in the case of this unfortunate physician was easily obtained—the man had had a chronic headache and repeated colds and the "throat and nose" specialist had requested and obtained radiographs of the man's frontal sinus, the exposures being made anteriorly and posteriorly.

Fortunately, in *x*-ray alopecia the prognosis is almost always good, but some of the victims frighten us a good deal because their recovery is sometimes delayed for months. Proper treatment hastens perceptibly the regrowth of hair and should always be employed.

We come now, gentlemen, to the crux of this lecture—the loss of hair due to the admixture of heredity and infection, the so-called *alopecia prematura seu alopecia furfuracea.*

When a young person comes to consult you for loss of hair of the type now under consideration you will almost always glean two facts—*i. e.*, a present or a past dandruff and the story that the father, or the older brother, or the grandfather lost

his hair early; less frequently that the mother or the grandmother suffered the same fate—in other words, it is much more often the male who is attacked and who in his turn propagates the disease than the female. Thus I personally consider heredity the principal cause of alopecia furfuracea; in other words, the future victim is born with a lack of immunity to the bacterium of seborrhea and whether he acquires the infection or subsequently produces an immunity to it depends upon the conduct of his life and the treatment of his scalp. It is the conduct of his life in this respect and the care of the scalp which have prompted me principally to present this thesis on premature baldness and which we will now discuss.

Hygiene of the Hair.—A healthy body militates against future dandruff. Plenty of sleep, simple food eaten slowly, abundant daily and not too violent exercise in the open air, daily bathing, but not of the scalp, good morals, and avoidance of excitement should be our aim, for our statistics show that the young men and women who lead nerve-racking, sedentary lives combined with too rich and too abundant food and drink are the all too common sufferers from this affection. The hygiene of the scalp throughout early life means much to its future welfare, and there can be no doubt that the prevailing ignorance of the care of the hair must be fought by a campaign of education if we want to restore to civilization the full heads of hair which the savage still enjoys.

Let us begin with the child. There is no hard-and-fast rule as to the exact frequency with which a scalp should be cleaned. As soon as an abnormal amount of grease presents itself the hair should be washed. This maxim should obtain throughout our lives. In early childhood the average scalp should be shampooed once a week because we know how rapid metabolism is at this period of life.

Adolescents should wash their heads once in two weeks as a good average. After the age of puberty we should all shampoo once in three or four weeks according to the dryness or greasiness of our scalps. As to the choice of soaps we must be guided by circumstances—a greasy scalp requires a drying soap, such

as castile or ivory or possibly tar; a normal scalp is best served by any good so-called toilet soap; a dry scalp is best washed with a superfatted soap. It is, therefore, evident that the increasing practice of the daily sousing of the head in shower-baths and in ocean or fresh water bathing is a custom to be severely condemned. Our scalps and hair are normally oiled by a special fat secreted by our sebaceous glands, and any constant artificial removal of this normal fat must of reason prejudice the well-being of our hair.

The question of our head coverings must be taken into consideration. A moment's thought will reveal the fact that those races which have never worn hats are today spared the humiliation of baldness, and so our false prophets have cried that if we don't want to lose our hair we must follow their example and go hatless; but these men forget the dangers of too great cold and too great heat to men whose ancestors have for generations protected their hair and their brains from the extremes of our so-called temperate climate. It can be safely argued, I believe, that our modern fashion of trimming the hair short does not afford men, at least, sufficient protection against the winter's cold or the summer's heat. Then, too, we must remember that the African negro and the American Indian, our models in this respect, are provided with dark and greasy skins and black and oily hair, conditions which protect them from the dangers of the summer sun. But there is a lesson to be learned from these facts, nevertheless, and a wise compromise to be made. Let us, therefore, counsel a warm, loose head covering in the cold months of the year, no headgear in the really temperate periods, and a flexible, easy, light straw hat during the hot months when we are actually in the direct rays of the sun, and this is especially true when on the bathing beach, for the drops of water on our hairs act as individual burning glasses. There is also one exception to these temperate and warm weather rules. Always insist on a hat at all times when motoring—the dust of a road is dirt, dirt which may contain sputum, feces, and urine, dirt which it would seem wise to keep out of our head. Finally, let us most emphatically advise against the prevailing

custom of wearing hats in the house, in the office, in the club, and on long hot railway journeys.

From the beginning the selection and care of hair-brushes and combs should receive attention in our almost inevitable struggle against scalp infection. Girls and women do not need brushes and should never use them. Fashion decrees that the hair of men must lie flat, and thus brushes for them become a necessary evil, but let them choose the softest brushes compatible with this unwritten law. We all require combs. Let them have long, blunt teeth placed far apart, and avoid those of porous material. Never sanction the use of combs or brushes to remove dandruff or dirt, for this maneuver merely adds fuel to the flames—trying thus to remove the products of infection we merely infect the scalp still further. Combs and brushes must be kept as aseptic as possible and we must recommend strongly as a minimum a bi-weekly soap-suds bath with subsequent immersion in alcohol and a final exposure to the sun for several hours. Combs or brushes should never be lent or borrowed, and an individual's own utensils should always be taken to the barber or the hair dresser and subsequently treated as described above. It is a curious law that prohibits public combs and brushes in hotels and sleeping cars and allows them in those hot-beds of infection which we call barber shops and hair-dressing parlors. The use of side combs is an unnecessary evil and should be discouraged. Hairpins should be boiled frequently.

Barber shops are a necessary part of civilization, but we physicians must in future exert our influence toward their more hygienic management. Regular customers should be obliged to bring their own combs, hair-brushes, and shaving brushes; and the present custom of storing at the shop their individual implements should be abandoned, for the dust of such an environment is impregnated with other men's diseases; changes and substitutions can occur and there can be no certainty that these necessary articles are ever cleaned and protected from subsequent contamination.

Freshly sterilized combs and brushes should be supplied to transient patrons at an increased cost, of necessity, and razors

and scissors and especially clipping machines, also freshly sterilized, should be provided for every customer. It should no longer be possible that a barber should treat a fresh customer without washing his hands, that he should drop a utensil on his thoroughly infected floor and apply it without further ado to a man's head, that he should take from the used towel receptacle a dirty towel to wipe the dust from a man's brush, that he should wet with his saliva a finger to test the sharpness of a man's razor. These, gentlemen, are no exaggerations, but practices which have been observed personally in some of the best barber shops in America.

From what has been said it is evident that much must be done to counteract the fate that lies in wait for the individual who has inherited no immunity to the organism of seborrhea. When this bacterium has gained an entrance to a favorable soil, dandruff results, and, if left uncured or untreated, loss of hair ensues sooner or later in the great majority of instances.

The **diagnosis of seborrhea** or of its sequela, alopecia furfuracea, requires no great skill. The scurfy scalp, the dandruff on the coat collar, the itchy head, the reddened skin, the dry or greasy hair, the retreating forehead, the gradually developing tonsure, the insidious general thinning of the hair, are all, alas, too frequent pictures all about us and need no further consideration here.

Treatment of Alopecia.—And now, gentlemen, we have described the different varieties and types of premature baldness. What can we do to cure or relieve them? Before telling you what seem to be the best modern applications let me ask you to rehearse in your minds the contributing factors as they have been described and enumerated, and then do you, in your turn, apply them to each individual condition. These factors should perhaps be your main guides toward treatment, for without such prophylactic injunctions your care of the case would be futile.

Ointment A.

℞. Sodii biborat..... 25
Ceræ albæ } ..... āā 3 5
Sulph. præcip. }
Aq. rosæ..... 8
Ol. petrolat..... 20

S. Sulphur cream.

For the first month this ointment should be applied in the least possible amount directly to the scalp one night a week; for the second month one night in ten days; for the third month one night in two weeks; and subsequently the day the hair has been cut or as soon as grease collects on the skin or the hair. On the mornings following the applications of the ointment the scalp should be shampooed with an appropriate soap (*vide supra*).

Three mornings a week (never at night) one of the following washes should be rubbed gently on the scalp:

Wash A. (If there is dandruff.)

℞. Hydrarg. chlorid. corrosiv. 25
Euresol (pro capillis) 8
Sp. formicarum 30
Ol. ricini 0–10
Alcohol ad. 250

Or Wash B.

℞. Acid. tartaric. } ää 2
Chloral hydrat. }
Ol. ricini 0–8
Alcohol ad. 200

Or Wash C. (If there is no dandruff.)

℞. Pilocarpin. nitrat 0·65
Quinin. sulph 6·5
Tr. canthar. } ää 12
Tr. capsic. }
Alcohol ad. 250

Or Wash D. (If the hair is oily.)

℞. Hydrarg. chlorid. corrosiv. 2·5
Aq. ammoniæ 4
Sp. æther. } ää 25
Sp. lavandul. }
Alcohol ad. 250

Syphilis.—In this specific instance of infection the best results are obtained, of course, from appropriate internal treatment with salvarsan and mercury in combination, but the local disinfection and stimulation of Ointment A and Wash A will perceptibly hasten the return of the hair and free the patient from the patent, tell-tale evidence of his shame.

Ringworm and Favus.—There is only one good modern treatment for these localized infections, and that is depilation by means of the *x*-rays, but this maneuver requires the coöperation of a trustworthy, competent, skilful radiologist. There must

be no dangerous overexposures, for relatively harmless diseases must not be complicated by disastrous sequelæ. Let me ask you not to apply ointments to the affected areas five days before a contemplated *x*-ray exposure or for a space of ten days subsequently, because grease alters the susceptibility of the skin to the rays, and if, by mischance, a resultant dermatitis actinica is developing fats invariably render the exposed skin more vulnerable. Two weeks after the exposure we should apply night and morning the following:

Ointment B.

℞. Beta-naphthol..... 2
Sulph. flor. } ..... ää 4
Acid. carbol. }
Vaselin..... 32

This antiseptic, stimulating salve rather rapidly destroys the remaining epidermic infection (for *x*-rays are not parasiticidal but merely depilating), and also tends to hasten the regrowth of the new hairs.

Alopecia Areata.—In this disease our local indications are to destroy the microbacillus, which is present in such pure quantities in the so-called peladic utricle, and to encourage the new growth of hair, and therefore apply to the bald areas every night and to the whole scalp once a week Ointment A or perhaps better still:

Ointment C.

℞. Ol. cadin. }
Acid. salicyl. } ..... ää 2
Sulph. præcip. }
Vaselin..... 32

These ointments must be thoroughly washed from the scalp on the following morning by means of castile soap and subsequent swabbing with alcohol. Then apply with great caution

Wash E.

℞. Ol. tiglii..... 1–3
Ol. terebinth..... 48

diluting this wash at first with alcohol if papules, vesicopustules, or soreness develop.

x-Ray Alopecia.—After the regulation two weeks' interval the scalp can be stimulated very properly and efficaciously with Ointment A and Washes A or B.

Alopecia Furfuracea.—The treatment of this common affliction is the same as that recommended under the heading of general infectious diseases. Remember all the prophylactic measures described and enumerated above and take care to warn your patients that this is a long and tedious process—in fact, that it must be pursued diligently and faithfully for years to come. Remind them that dentists have educated them to take perpetual care of the teeth by daily brushing and frequent dental examinations, and make them appreciate the fact that hair and teeth are formed of essentially the same substance, and that both are liable to the deteriorating influences of modern civilization. By such advice only, it seems to me, can we encourage our patients to follow this long and arduous path of duty. Let us be guided by the principle that baldness is not a necessary evil, and that by incessant and therapeutic care it can be made to disappear from our sight.

Finally, in all these various types of alopecia skilful massage is of great service, but never let it be employed when visible signs of inflammation are present, and among these signs dandruff is to be especially included.

This, gentlemen, completes this presentation of this practical question which affects sooner or later so many members of our community. It is not a trifling subject, and any man who has witnessed the unhappiness and mortification of the many victims of alopecia will bear testimony to the truth of this assertion.

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ECZEMA IN CHILDHOOD

Clinical Manifestations; Objective Symptoms; Etiology; Management and Treatment; Necessity of Investigating Each Case Carefully and Outlining the Treatment According to the Etiology.

December 1, 1917.

THE earlier teachings concerning eczema and childhood were confined to the skin alone, because the knowledge at the time was limited to what could be seen by the naked eye and under the microscope. Eczema, therefore, belonged in the domain of dermatology, and the emphasis of treatment was laid on external applications to the skin. Although in some instances such applications were quite satisfactory, and apparently cured the eczema, there still remained a large group of cases which only showed slight or no improvement. Investigators, therefore, commenced to look elsewhere for a cause which might be back of the skin manifestation. It was then found that the digestion played a very important part in the cause of eczema and, therefore, the service of the pediatrist was necessary to regulate the diet of the child. As time went on, the relative importance of the two specialties became reversed, so that at present it is fair to say that eczema in childhood is a disease which falls primarily into the domain of the pediatrist, later going to the dermatologist, when necessary, for local treatment. Sufficient knowledge of metabolism, digestion, and dietetics in infancy and childhood can only be attained by those who make a special study of the diseases of children, and the knowledge of facts necessary for a com-

plete understanding of the processes of digestion is attained only after many months of study and experience, while the number of external applications which are of any real value in the treatment of eczema in infancy or childhood are so few that they can be learned in a short time. If one specialty is to be consulted, that which can do the most should be selected. Eczema in infancy and childhood, therefore, is best placed in the specialty of pediatrics.

The following summary and case reports undertake to cover briefly the essential points known about eczema in infancy and childhood, and tend to show the relation of the older assumption of its external origin, to the more recent facts brought to light concerning its internal origin.

Clinical Manifestations.—Eczema in infancy and childhood does not show so many varied types as in the adult. The commonest symptom is itching, which is present in the great majority of cases, although occasionally it may be entirely absent. It may be coincident with or preceded by a skin eruption. As a rule, the itching is not constant, its appearance being associated with digestive symptoms. Usually disappearance of itching precedes an improvement in the skin. This irritation is present to such a degree in the eczemas of infants and children that even when the child is pinned down to the bed in such a manner that it cannot scratch, I have seen it wriggle into inconceivable positions in order to obtain friction of the affected parts. Gentle friction with the hand will often quiet an infant who is trying desperately to scratch itself. The scratch-marks leave raw, oozing, bleeding patches, which are easily infected, and may result in an impetigenous eczema. A nervous irritability is also a common symptom, which has led some of the German School to attribute eczema to a "neuropathic diathesis." This nervousness, in my opinion, is a secondary symptom rather than a primary cause.

Objective Symptoms.—In infants and young children the commonest form of eczema is seen especially on the face, cheeks, scalp, and back of the ears, and is called by Marfan and Feer the oozing, crusted eczema, in contradistinction to the disseminated, dry eczema. This type of eczema usually commences on the

cheeks, with the formation of small red papules, which coalesce, and, if rubbed, become red and oozing. The secretion dries in thick crusts, and when scratched bleeds easily. The skin, in these cases, is usually thickened, and the lymph-nodes are always enlarged in the neighborhood of the affected areas. The general health later becomes impaired if the eczema persists any length of time. This, however, is probably not due to the skin eruption, but to the condition underlying it. In some instances the eczema alternates with attacks of asthma and bronchitis. Patients suffering from eczema are likely to have periods of diarrhea associated with improvement of the skin. Earlier observers have laid much stress upon these coincidences, and believed that it was not good to "drive an eczema in." An example of this is shown in the case of a boy of ten years who came to me because of asthma. His history showed that he had had a severe general eczema, which external treatment did not affect, until he was thirteen months old, at which time a new ointment was applied to the skin and resulted in immediate improvement. Coincident with the disappearance of the eczema he had his first attack of asthma. It might be assumed that the eczema was driven in, with the resulting asthma as a consequence, but there is sufficient evidence to prove that some types of eczema and asthma are the same disease, with symptoms in different parts of the body. In the majority of asthmatic cases there is a history of an early eczema, but the fact that a child has eczema does not necessarily mean that later it will have asthma. Conversely, a few cases of eczema are followed by asthma or an idiosyncrasy to some food.

The crusted form of eczema very often stops at the beginning of the second year, when there is a reduction in the quantity of milk an infant takes in the day, and other foods are added to the diet. It is a curious coincidence that the eruption of teeth is very frequently associated with an exacerbation of eczema. In nearly all these cases, when the teeth are coming through, the eczema, which may have entirely disappeared, returns until the teeth are through the gums. It should, therefore, be borne in mind that even when the diet has been properly regulated, erupting teeth may cause a relapse in the skin condition.

A second type of eczema, which is seen in late infancy and childhood, is the dry, disseminated, scaling form. This is the most chronic form, and the earliest lesions to appear are so similar to certain forms of urticaria that it is often impossible to distinguish between the two. As time goes on the urticarial-like eruption becomes a typical eczema. This sequence of events can be produced experimentally or accidentally by giving too much egg to an individual who has an idiosyncrasy to hen's egg. There is little doubt in my mind that this form of eczema is usually a late stage of urticaria. The general glandular enlargement, seen in these cases, is often associated with an enlarged thymus. This might be taken as an explanation of the sudden death which occurs occasionally in eczema, and which pathologic section designates as status lymphaticus.

A study of the differential count of the blood in eczema, asthma, afebrile chronic bronchitis, and urticaria shows an increased number of eosinophils in the blood, often as high as 10 per cent.

Etiology.—The diversity of opinion as to the causes of eczema is due to the fact that the means used in studying the cases were not sufficiently accurate to demonstrate any factor of etiologic significance. More recently it has been possible to differentiate the various types of the disease by microscopic examinations of the stools, or by the skin tests with foreign proteins.

The commonest exciting external causes of facial eczema in children with a delicate skin are cold, dry winds, which alter the physical composition of the exposed parts, and the use of hard water or strong soaps, lack of cleanliness in the folds of the skin, irritating discharges from the nose or ears, and acid, burning stools. Infants' and children's skin is more delicate and more easily harmed than an adult's. There are certain skins that are peculiarly susceptible to different forms of external irritation.

CASE 1.—C. O., girl of five months, is an example of the simplest form of eczema due to external irritation. She was breast fed, and at three weeks eczema broke out on the face and spread until both cheeks were rough, red, and oozing serum. This eruption appeared on the first raw, windy day this winter and

became progressively worse, especially when the face was washed with soap. The use of soap was stopped, and a simple zinc oxid ointment was applied. In all probability the eczema will then clear up if the child is kept out of the cold, sharp winds.

The treatment of eczema from internal causes is a different problem, as it is much more difficult to find a definite etiologic basis in these cases. Sometimes, however, by a careful study of the diet, and the sequence of events, enough evidence may be accumulated so that it is possible to determine the causative agent. A common cause is usually found to be overfeeding, and according to the figures of More and Kolb over half of the children with eczema are overfed, only 26 per cent. being undernourished. In my experience the physical development of the patients would seem to substantiate these findings. but a closer study of their diets show that overfeeding alone is not the sole cause in a large majority of these cases of eczema. The commonest food component to cause eczema, when given in excess, is fat. A typical example of this is shown by the following case:

CASE 2.—E. P., a boy of six months, has an oozing eczema of the face of two months' duration, which presents the typical text-book picture. He was entirely bottle fed, had no symptoms of indigestion, but was slightly constipated. He was on a formula of fat 4.5 per cent., lactose 6 per cent., and protein 1.5 per cent., 7 ounces every three hours, six feedings. He was gaining regularly, and, aside from the eczema, acting well. The scratch-marks on his face and the way he rubbed his head on the pillow showed that itching was a prominent and distressing symptom. The mother says that when he first came to the clinic it was so bad that he slept very little at night and was very irritable. The first examination of the stool, two weeks ago, was as follows: Grayish yellow, smooth, a little dry, and crumbly. Under the microscope it showed a large excess of fat in the form of soaps. (The technic employed in the microscopic examination was that described in the Boston Medical and Surgical Journal, 1910, clxii, page 134). Since he was receiving more fat in his food than is usually considered wise, and since there was an

excess of fat in the stools, the amount was reduced to 2 per cent. The mother reported later that the eczema immediately commenced to improve. Today's stool examination showed only a slight excess of fat. We purpose, therefore, to reduce the amount of fat to 1.75 per cent., and to increase the amount of protein to satisfy the baby's hunger as well as to give him enough calories to grow, and expect that when he next reports the itching will have stopped entirely, and there will be further improvement in the skin.

This type of case is so common in infancy that many practitioners reduce the amount of fat in the food in all cases without examining the stools. In most cases this procedure would be justified by the clinical improvement which is likely to follow, but there is a small percentage of cases in my experience which do not show any fat in the stools, and in such instances a reduction of the fat would unnecessarily take away a desirable food. It is safer, therefore, to always examine the stools under the microscope, even in cases which seem to be complete without such an examination. In this connection it is wise to bear in mind that the power of digesting fat varies in different individuals, and that amounts which would be normal for one would be an excess for another. The fact, however, that there is only a small amount of fat in the food does not mean that the fat has no connection with the eczema.

It is difficult to explain why fat is not tolerated and absorbed well by most eczematous children. There must be some abnormality in the absorption or in the internal metabolism of the fats. Up to date, however, science has offered us no suitable explanation for a well-established clinical fact. External applications in this type of case are, of course, of considerable value in controlling the itching and allaying the irritation, but in the majority of instances they play a lesser part in the complete cure than does the diet.

Eczema may also be associated with an excess of starch in the stools, and although this is not a common finding, its reduction in the diet usually results in an improvement in the skin. If there are signs of indigestion, these symptoms im-

prove with the eczema. Since all starch contains some protein, even though in small amounts, it is not possible to say definitely whether the starch or the protein in the starch is at fault.

Before considering the rôle of protein in eczema it is necessary first to speak briefly of the salts in the food. The Finkelstein School reports cures of infantile eczema by giving a food poor in salts. My experience with this method is so slight, and the knowledge of the part the salts play in the metabolism so small, that I will not venture to judge this method of treatment. It is possible that there is some connection between an excess of salts in the food and too much fat in the stools.

The rôle played by protein in eczema cannot be demonstrated by an examination of the stools. There are many facts, however, which lead investigators to consider eczema a symptom of anaphylaxis to a foreign protein. The earliest suggestion of this was made by Czerny who described the clinical entity "exudative diathesis," in which he includes eczema and asthma. It fits in, however, so nicely with sensitization to foreign proteins that it is probable that most of its symptoms are manifestations of anaphylaxis.

The next group of cases are examples of eczema primarily due to special foods. This group deals with sensitization to foreign proteins or anaphylaxis. Examination of the stools is of no value in determining the cause of this type of eczema other than showing to what an extent a fat indigestion complicates the picture. As a rule, a large proportion of these cases have too much fat in the stools, but in my experience this is only of secondary importance in the dietetic treatment of the disease. External irritation also plays a secondary part in this group of cases, which are said to be due to anaphylaxis. The following 2 cases are examples of the anaphylactic type of eczema:

CASE 3.—E. B., girl five years old, has had eczema all her life and had received all kinds of external treatment, without improvement. Her eczema could be described as a general, discrete, papular eczema, scattered over the entire body. Other-

wise the physical examination was normal. Skin tests were done for various foods, according to the method described by Schloss (American Journal of the Diseases of Children, 1912, vol. 3, page 341), and positive reactions were obtained to hens' eggs and cows' milk. Negative reactions resulted from the other proteins tried. Egg was, therefore, entirely omitted from the diet, and the milk boiled and reduced in amount from a quart to a pint a day. The diet, otherwise, was unchanged, and within five days the eczema had entirely disappeared. Two weeks later, during which time she had been free from eczema, a hard-boiled egg was given, and within eighteen hours an urticarial-like eruption appeared on the skin, which the mother said resembled the onset of the previous eruptions, which later turned into eczema. Since then egg has been entirely omitted from the diet, and as a result the skin has been perfectly normal.

CASE 4.—G. D., girl, seventeen months old, was weaned at four months and given a formula of modified milk which was followed shortly by a scattered, papular, scaling eczema over the back of the neck and trunk. Otherwise her physical examination was normal. Skin tests for the following proteins were done: hen's egg, which resulted in a very large reaction, cows' milk, a moderate reaction, and rice, a slight reaction. (The methods of preparation of the vegetable proteins are described in the Boston Medical and Surgical Journal of March 29, 1917, and July 19th, 1917.) A microscopic examination of the stools showed a very small amount of fat. On the basis of these findings egg and rice were omitted from the diet and the milk was boiled. One month later the parents report that the eczema had almost entirely disappeared. In the interval rice was given once, and resulted in a fresh eruption on the skin. The offending articles of food in this case were primarily egg and rice, and secondarily milk.

Some time ago while desensitizing a child that was sensitive to eggs, I found that if too much egg was given to the patient there resulted an eczematous eruption on the skin, which disappeared on reducing the dosage. Schloss had previously made the same observation, and has reported, in discussions, results

of his investigations. Blackfan, at about the same time, studied sensitization to foreign proteins by means of the skin test. The connection between asthma, eczema, chronic afebrile bronchitis, and urticaria has long been suspected. The point in common in all of these diseases is an increased number of eosinophil cells in the blood, 6 per cent. is quite usual, and 12 per cent. not uncommon. Schloss has shown that if a foreign protein is injected into small animals, there is an increase in the number of eosinophils in the blood on the eighth to the twelfth day following the injection at about the time sensitization was commencing. This leads one to assume that there is some relation between the two phenomena. If it is true that eosinophil cells are an index of sensitization, then anaphylaxis must play a part in all cases showing an eosinophilia. When an infant is given cows' milk for the first time the blood shows an increased number of eosinophils between the eighth and twelfth days, after which the differential count becomes normal again as the baby "becomes used to the milk." Evidence other than the frequent positive skin tests to foreign proteins, the clinical sequence of events, and an eosinophilia is lacking to establish an anaphylactic cause for eczema, but the fact that eczema will disappear from the skin of a child giving a positive skin test to egg when the egg is removed from the diet, and will return again when egg is given, is prima facie evidence that the egg is the cause of the eczema in this case.

The question is often raised as to how specific the skin test is, and whether a positive test may not be obtained in healthy individuals. In answer to this I may say that a routine skin test for egg-white was made on 100 unselected infants and children entering the Children's Ward at the Massachusetts General Hospital, and only one positve reaction was obtained, and in this case there was a slight eczema. Blackfan found only one patient which showed any evidence of susceptibility to protein by cutaneous or intracutaneous tests.

The following table gives the results of positive skin tests in eczemas:

Protein.	Blackfan,[1] 21 cases.	Schloss,[2] 43 cases.	Talbot, 16 cases.
Egg-white	21	14	14
Cow casein	17	12	4
Human milk	10	3	
Barley	8		0
Horse-serum	7		2
Meat extract	6		3
Rice			5
Oats			3
Orange			1
Corn			1
Fish			1

Many cases of eczema react to more than one protein, and it is often difficult to determine what particular protein is causing the most trouble. When a positive skin test is obtained, it is best, except in rare cases, to remove the offending protein from the diet, after which the skin eruption almost invariably disappears. Unfortunately, however, some cases do not give any positive skin tests. I have in mind one particular case in which sixty different proteins were tested without any positive tests. Very often, also, a positive skin test is of no value in the treatment of eczema, as, for example, in the case of the child who reacted to corn pollen, but gave negative reactions to the food proteins. It is obvious that the corn pollen could not be the cause of the eczema.

In *treating cases of eczema due to anaphylaxis* two classes must be considered. The baby on human milk is an example of one type of case:

CASE 5.—R. T. H., girl, three weeks old, entirely breast fed and gaining normally, when a fine papular rash appeared on the cheeks and body. A careful study of the mother's diet revealed the fact that previous to the appearance of the eruption on the baby's skin the mother had eaten about a pound of chocolate candy. Chocolate was, therefore, omitted from the diet, with the result that the baby's eczema immediately disappeared. After two weeks' time chocolate in the form of cocoa was taken,

[1] Blackfan: Amer. Jour. Dis. Chil., 1916, xi, p. 441.

[2] Transactions of the American Pediatric Society, 1915, p. 60.

and within twenty-four hours the same papular rash again appeared over the baby's face and neck. Chocolate in all forms was, therefore, entirely omitted from the mother's diet, and since then the baby has showed no signs of further eruption. This case was easily handled after it was found that chocolate in the mother's diet was the cause of the eczema.

Another type of case in this class gives a positive skin reaction to either human or cows' milk, or both, and by omitting the milk from the diet becomes entirely well in about five days, only to have the eczema return again after a few days, without any explanation. It is a difficult problem to feed a baby on a food which does not contain milk in any form, and since such a procedure is not without risk to the baby, I have, therefore, stopped using it, particularly since improvement is not permanent.

The second class of cases in the anaphylactic group is seen in children of twelve or more months of age whose diet contains other foods than milk. Treatment of this class of cases is easier because there are a variety of foods which may be given to the child. If a positive reaction is obtained to the protein of rice in this group, as has happened in 5 of my cases, rice may be entirely omitted from the diet without any hardship to the child. Positive skin tests in older children with eczema are, therefore, of great value in planning the dietary treatment of the disease.

In the treatment of eczemas due to foreign proteins there are certain principles that may be applied. In the first place if a positive skin test is obtained, it probably is of etiologic significance, and, therefore, the protein to which the skin has reacted should be removed from the diet. Egg, which is the commonest offender, may be removed from the diet of a child of any age, whereas milk, which takes a larger and more important part in the dietary of the child, cannot be replaced by any other food. Laboratory experiments have shown, however, that when a foreign protein, as a specific example, we will take cows' milk, is heated to 240° F., a change takes place in the milk and it no longer causes an anaphylactic shock in a sensitized animal. Boiled milk acts in a similar way, but to a lesser degree. Therefore when milk cannot be excluded, it should be boiled. In a

few individuals that are sensitive to cows' milk small quantities of milk may be taken with impunity, while a large quantity causes indigestion. Under these circumstances it is wise to boil the milk and then give the largest quantity that can be taken without symptoms. Milk, furthermore, can be modified by inoculating it with a lactic-acid-forming bacteria. This affects the eczema favorably in some unknown manner. Subcutaneous inoculations of foreign protein may be employed to desensitize a patient. This procedure, however, is not free from danger, as it has been known to cause anaphylactic shock. In infancy, at least, it is better not to use subcutaneous inoculations, since they might result in death. As a substitute, desensitization by rectal injections of cows' milk may be used, enough milk being absorbed by the mucous membrane of the large intestine to desensitize the patient. In the case of other foods, such as rice, wheat, oats, and orange, etc., it is better to omit them entirely from the diet.

Summary.—The simplest form of eczema is that due to external irritation. As the disease becomes more complicated, we have added to this a lowered power for digesting fat, and on top of that, in the most complicated cases, a food sensitization. In order to demonstrate which of these three factors play the predominating rôle it is necessary to investigate each case carefully and outline the treatment according to the etiology.

CLINIC OF DR. HARRY A. BARNES

MASSACHUSETTS GENERAL HOSPITAL (NOSE AND THROAT DEPARTMENT)

VINCENT'S ANGINA

Differential Diagnosis; Is Vincent's Angina a Clinical Entity? Bacteriology; Etiology; Symptoms; Treatment.

December 1, 1917.

A. M., male, twenty-three years old, worker in a cotton mill, gives the following history: Ten days before coming to the hospital he awoke in the morning with a sore throat confined to the right side. There were no constitutional symptoms severe enough to make him remember them. The next day swallowing became very painful, and he consulted a local physician, who told him that he had an acute tonsillitis and advised an immediate tonsillectomy. The patient declined operation and kept at work, feeling somewhat under par, but having none of the general symptoms usually associated with acute infection. Swallowing has remained very painful and this discomfort is still confined to the right side. He has had occasional chilly sensations, but no actual chill. One week ago he noticed a slight swelling on the right side of the neck near the angle of the jaw, and this swelling has been somewhat tender to the touch for the past three days. He has never had a sore throat before and, with the exception of a gonorrhea two years ago, gives a negative venereal history.

Physical examination shows a man of medium size, well developed, but with a somewhat pinched and pasty look. Temperature 99.2° F.; pulse 78 and of good quality. The tonsillar gland on the right is enlarged to the size of a walnut, is freely movable, non-fluctuating, and tender on palpation. No other

glands are involved. On examination the jaw opens freely and there is no general swelling in the faucial region. The median raphé of the palate is in the central line. The tonsils are of moderate size and are fairly prominent beyond the faucial pillars. The right tonsil shows an ulceromembranous condition embracing all of its epithelial surface except a small area posteriorly near the supratonsillar fossa. The lesion extends anteriorly slightly over the border of the anterior pillar. Its edges are slightly uneven, though not ragged, and are slightly redder than the surrounding healthy tissue, but are not raised or everted. There is evidently considerable loss of tissue, as the surface of the ulceration is slightly concave, whereas the normal contour of the tonsil is convex. The tissues immediately surrounding the lesion are somewhat injected, especially at the base of the anterior pillar, where a network of fine capillaries may be seen. On the left tonsil is a similar lesion of much less extent and without any apparent loss of substance. The patient has not been aware of any trouble on that side. The breath is foul with an odor suggestive of Vincent's angina. (I may say here that odors arising from membranous and ulcerative lesions of the throat and mouth are by no means as distinctive as the odors of certain nasal lesions, such as syphilitic bony necrosis or atrophic rhinitis, which may often be diagnosed from smell alone. Nevertheless, information gained from them may be of great value even if we are obliged to admit that such evidence is often of an intuitive nature.) On wiping the surface of the lesions with a cotton-tipped applicator the membrane is found to be easily removed, very friable, and of a pultaceous, almost granular consistency, not unlike a thick paste of cigar ash. The exposed surface is uneven, slightly lobulated, and has numerous small bleeding granulations showing through the thin necrotic base. To the touch with the gloved finger there is no noticeable induration. The ulcerated surface on the right is extremely sensitive.

Differential Diagnosis.—We have here an ulceromembranous lesion of the fauces in which the diagnosis lies chiefly between diphtheria and Vincent's angina. Other affections, however, cannot be ignored, and we will consider them in inverse order

PLATE 2

VINCENT'S ANGINA

This illustration was made directly from the case reported in this clinic.

of the likelihood of their being the correct diagnosis in this case. For immediate diagnosis the microscope is our best aid. Two smears have been taken from the lesion on the right—one for examination with the dark field illumination; the other for ordinary microscopic examination after staining with carbol-fuchsin.

Acute Streptococcus Tonsillitis (Septic Sore Throat).—The duration of the disease, with only the mildest of constitutional disturbance, is sufficient to rule this out. During the first forty-eight hours I should think this might have been considered seriously. Cultures and smears would have corrected any error.

Syphilitic Ulceration (Tertiary).—The sudden onset, the glandular involvement on the right with tenderness on palpation, the character of the ulceration, and more particularly of the exudate or membrane, make this diagnosis extremely doubtful. Examination of the blood for a Wassermann reaction should be made if such a lesion fails to respond to ordinary methods of treatment.

Primary Syphilis (Chancre) of the Tonsil.—This affection is not so easily disposed of. The fact that the lesion in this case is bilateral certainly does not favor it. The character of the glandular enlargement does not suggest it. In chancre of the tonsil not only is the tonsillar gland enlarged (as it is in this case), but usually the whole group of upper cervical glands under the sternomastoid is involved, making a very pronounced swelling in which the outlines of the individual glands cannot be distinguished. However, this lesion is only ten days' old and sufficient time has not elapsed for the full development of a primary bubo. Also I may say that only last week a patient came into this clinic with a primary lesion of the right tonsil, proved both by the presence of undoubted secondary lesions and by the presence of the Spirochæta pallida in smears taken from the tonsil, in whom the tonsil gland alone was enlarged, and that only to the comparatively slight degree present in our case of today. There was, however, no tenderness on pressure over the gland as there is in this case. The character of the ulceration with its grayish granular exudate does not suggest chancre. Chancre of the tonsil may be simply an erosion with very slight if any loss of

substance; or there may be well-marked ulceration with a dirty yellowish exudate hardly membranous in character. In either case chancre of the tonsil usually is a pronouncedly indurated lesion, sometimes the whole tonsil apparently being involved. The acute pain favors a diagnosis other than chancre, though occasionally initial lesions of the tonsil give rise to a good deal of discomfort in swallowing. A Wassermann reaction probably would not help in this case, as the reaction usually does not appear till the fourth or fifth week after the appearance of the chancre. Our dark field examination will probably settle this point satisfactorily.

Diphtheria.—During the first few days of the disease this diagnosis could only have been disposed of by culture and examination of smears microscopically. The character of the exudate at the present time suggests Vincent's angina. When we add to this the absence of any marked general symptoms during a period of ten days the diagnosis becomes still more probable. Both the smears taken from this case show large numbers of the Bacillus fusiformis and its accompanying spirillum. The dark field illumination fails to show the presence of the Spirochæta pallida. Our tentative diagnosis, then, is Vincent's angina. The blood will be taken for a Wassermann test; also a culture will be taken from the throat to exclude any possibility of diphtheria. I never have seen a case, however, in which the organisms of Vincent's angina were found in very large numbers in the smears that later showed positive cultures of the Klebs-Löffler bacillus.

The **treatment** of this case consists in removing the exudate with cotton dipped in a 1 per cent. solution of cocain to lessen the sensitiveness of the ulcerations, and the application of a 5 per cent. solution of chromic acid. This is very mild medication, but a few daily applications are usualy sufficient to effect a complete cure.

December 3d. The patient's subjective symptoms have largely subsided. There is still slight soreness of the throat on the right side, but practically no tenderness on palpation of the enlarged tonsillar gland. The ulcerations on the tonsils are much cleaner,

the membranous exudate thinner, and the odor less pronounced. The extent of the surface involved has not materially changed. There is only slight sensitiveness when the membrane is removed with the cotton-tipped applicator. The temperature is normal. The patient looks brighter and his color is improved. Cultures taken two days ago for the Klebs-Löffler bacillus were negative. Local treatment with 5 per cent. chromic acid will be continued. For the general condition the tincture of nux vomica in the glycerophosphates of lime and soda is excellent.

December 5th. The patient has failed to return, probably because he considers it unnecessary. Unfortunately, we were to have taken his blood for a Wassermann this morning, and that phase of the case must remain incomplete. In view of the other laboratory findings, together with the clinical manifestations of the lesions and their very prompt response to the simplest treatment, the Wassermann reaction is of comparatively little importance in this particular case.

The foregoing case is a typical example of one of the forms of simple ulceration of the fauces, characterized by the formation of a membranous exudate in which large numbers of the Bacillus fusiformis and its accompanying spirillum are found, and in which no other specific cause for the lesion can be demonstrated. Such lesions are now grouped under the common name of Vincent's angina. They vary within tolerably wide limits in their appearance, but are always ulceromembranous in character, and usually conform to one of two general types—those simulating diphtheria and those having more nearly the characteristics of late secondary specific ulcerations. They are usually confined to the tonsils, but may extend to other parts of the fauces and pharynx, or may even be primary on these parts. Occasionally they occur on the mucosa of the cheeks or gums. I have seen 2 cases in which the region of the lingual tonsil was the only part involved. Cases have been reported as primary in the larynx, trachea, and bronchi.

Whether these lesions constitute a clinical entity or not is a question not yet fully decided, as the fusiform bacillus and its accompanying spirillum, though always present in the membrane,

cannot be proved to have any but a casual relationship to the lesions. Inoculation experiments have thus far given negative results. Some observers believe that the lesions are started by the streptococcus and that Vincent's organisms are secondary invaders. The mild character of the general symptoms in the average case, however, does not suggest a streptococcus origin; and there are good reasons for believing that Vincent's organisms, ordinarily harmless and saprophytic in character, and often found in essentially normal mouths, may, under certain conditions of lowered resistance on the part of the host, become pathogenic. The lesions are common in the poorly nourished or in those debilitated by general disease; and the most destructive and fatal forms of gangrenous necrosis in which these organisms are found often occur in subjects with leukemia or one of the other essential blood diseases. The fact that at times it seems to be mildly contagious, when several people in good health and living in close association are attacked successively, indicates a specific relation of the organisms to the lesions. This supposition has certainly not been weakened by the pronounced effect that the arsenomercurial preparations, so successful in the treatment of syphilis, have upon the disease. Certainly the lesions usually seen in the throat in which these organisms are found in preponderating numbers constitute a clinical picture distinctive enough to be considered an entity, and I think they are regarded as such by a consensus of present opinion.

Vincent's angina is an ulceration of the mucosa characterized by the formation of a necrotic membrane in which the Bacillus fusiformis and a spirillum are found in predominationg numbers. The lesions are usually confined to the tonsils, but no part of the upper respiratory and gastro-intestinal tract is exempt, though cases involving the larynx, trachea, and bronchi are rare. The ulceration is usually not deep, but it occasionally becomes so, and more or less of the whole tonsil may slough away; or it may spread to the surrounding tissues, and the faucial pillars, the palate, and the pharyngeal walls become the seat of a destructive gangrenous necrosis.

Bacteriology.—The Bacillus fusiformis as seen in smears

direct from the lesions is a double-pointed bacillus, somewhat swollen in the middle and often presenting a beaded or barred appearance due to a varying number of deeply stained granules in its protoplasm, which is elsewhere but lightly stained. It is non-motile and decolorizes by Gram. In anaërobic cultures its morphology is very variable. Some of its forms are sinuous

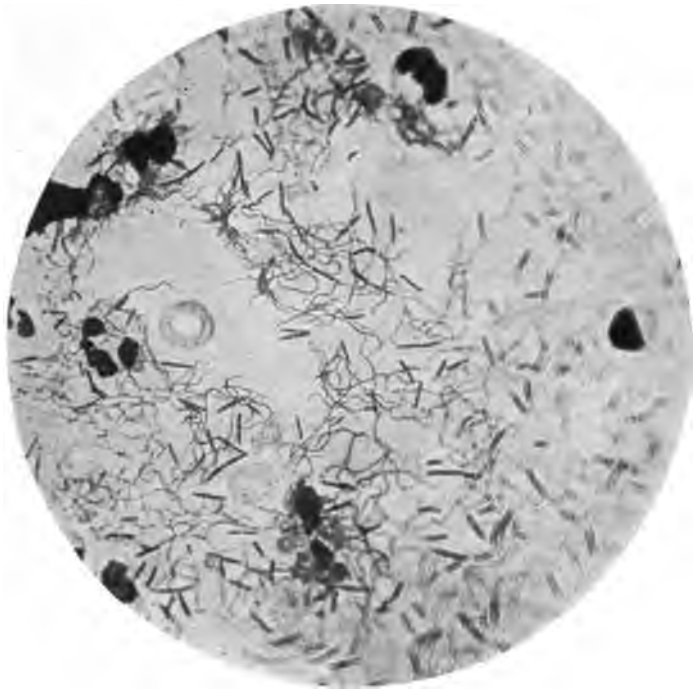


Fig. 105.—The organisms of Vincent's angina. At the periphery of the field the organisms are not in focus. (Barnes on the Tonsil.)

and when granules are absent simulate a loosely wound spirochete. The spirillum which always accompanies the bacillus is a corkscrew-like organism not unlike the Spirochæta pallida, but with fewer twists and wider spirals than the latter, and when seen under dark field illumination is more rapid in its rotary movement. Both organisms are anaërobic. They have been regarded by some observers as different developmental stages of

the same organism[1]; others consider them quite distinct and always growing in symbiosis.[2] They were first described by Miller in 1883 as occurring in normal mouths, but more especially in those of persons not addicted to the use of the tooth-brush. Their presence in the lesions of ulceromembranous angina was first reported by Rauchfus in 1893. Since then the organisms have been found in necrotic and suppurative processes of all sorts and in widely different parts of the body. Their association with the lesions of ulceromembranous angina was reported by Plaut[3] in 1894 and by Vincent[4] in 1896, and Vincent's subsequent work has given his name to the disease.

Etiology.—We assume that the above-described organisms are the direct cause of the disease. There are, however, certain predisposing causes that are of importance. Careless hygiene of the mouth is probably responsible for a large proportion of the cases of the less serious type. Combined with this, any of the causes of malnutrition make conditions favorable for the development of these lesions. Its more serious forms are usually secondary to other infections, such as diphtheria, scarlet fever, or measles. Patients with leukemia seem especially subject to the disease, and these cases usually terminate fatally. It is interesting to note that the disease is very common among the English and French troops in the trenches. Bouty[5] reports that it represented 23 per cent. of all the throat cases occurring in one of the large British military hospitals in France.

Symptoms.—The subjective symptoms are usually mild, as in the case here reported. The temperature is seldom raised beyond 99° F. and is often subnormal. Even the more severe and fatal cases are no exception to this rule. The breath is heavy and very offensive and often characteristic. Slight enlargement of the cervical or submaxillary glands is usual. The ulcerated surface is always exquisitely sensitive, and this soreness of the

[1] Tunnicliffe, Ruth: Jour. of Infec. Diseases, Vol. III, 1906, p. 148.

[2] Krumwiede, C., Jr., and Pratt, Josephine S.: Jour. of Infec. Diseases, Nov., 1913.

[3] Deutsche. med. Wochenschrift, 1894, xlix.

[4] Ann. de l'Inst. Pasteur, 1896, 488.

[5] British Med. Jour., Nov. 24, 1917, p. 685.

throat is the most marked subjective symptom. The membrane may be on one or both tonsils and is usually single. Sometimes it is multiple and discrete. When the ulceration is shallow and its edges not very sharply marked the lesion simulates diphtheria. When the edges are sharply defined the lesions present the punched-out appearance of the specific ulcerations. The membrane is usually ashy in color. It may be white, whitish gray, gray, grayish yellow, or even of a greenish tinge. It is very friable, pultaceous, and even granular, and is easily removed, leaving a granulating bleeding surface beneath. It quickly re-forms. The graver forms of the disease are fortunately rare. Large areas of the mouth and pharynx become involved and the necrosis extends deeply. The pulse is rapid and feeble and the prostration extreme. Glandular enlargement may be marked. Death usually results from exhaustion.

The diagnosis rests upon the finding of the specific organisms in smears taken from the lesions, and in the exclusion of other causes of ulceromembranous lesions, such as diphtheria and syphilis. Probably in a majority of cases the experienced observer may make the correct diagnosis by clinical signs alone; but this should always be substantiated by all the tests outlined in the case here reported.

The prognosis is good in a great majority of the cases. The ulcers remain superficial and heal in a few days without scarring. They sometimes last for weeks, however, and if the ulceration has been deep, scarring will probably result. In the debilitated or when occurring in the course of a leukemia, the necrosis is prone to become very extensive and may prove fatal, death resulting from exhaustion or secondary septic complications.

The treatment is usually simple. Locally chromic acid (5 per cent.), zinc sulphate (5 per cent.), silver nitrate (10 per cent.), tincture of iodin, or trichloracetic acid may be used. I have found chromic acid the most efficacious of all these. The last two should be used only on small ulcerated surfaces. General treatment is almost always indicated, and will be suggested by the individual case. Good food, regular habits, and, above all, the care of the mouth are essential. If the gums and teeth

are allowed to remain in bad condition, local applications to the lesions may be without effect, as a constant supply of Vincent's organisms may be furnished from these sources. A good dentist is one of the best of therapeutic measures. In cases in which these simple measures do not suffice or in which the necrosis extends rapidly or deeply, salvarsan or one of the other arsenomercurial compounds should be given. They appear to be as specific for this form of spirochetal infection as in syphilis, for the lesions heal with wonderful rapidity after their use.

CONTRIBUTION OF DR. ARIAL W. GEORGE, DR. RALPH D. LEONARD, AND DR. FREDERICK W. O'BRIEN

THE ROENTGEN DIAGNOSIS OF DISEASE OF THE UPPER RIGHT ABDOMINAL QUADRANT

The Anatomy of the Duodenum and Its Relations; Duodenal Ulcer; Comparison of the Direct Method with the Roentgenoscopic or Indirect Method; the Second Portion of the Duodenum; The Gall-bladder; Technic; The Large and Small Bowel; Value of Roentgen Evidence in Gall-bladder Disease.

FROM a roentgenologic point of view the upper right abdominal quadrant has become one of the most important somatic areas which we are called upon to study. We have included in this review of our findings the first and second portions of the duodenum, the biliary tract, and certain secondary influences upon them as reflected in changes noted by us in the small and large bowel.

It is with pardonable pride that we state that the positive advances made during the past ten years in the roentgenologic diagnosis of disease of the duodenum and gall-bladder are distinctly an American contribution to medical science made possible by the extensive use of the plate method in contradistinction to the roentgenoscopic (fluoroscopic) method employed by Continental workers.

We gratefully acknowledge the early work of Holzknecht, Haudeck, Schwartz, and others for supplying the stimulus for our later work, but to Cole, of New York, must go the major part of the credit for the progress made by American Roentgen workers in the field of gastro-intestinal diagnosis. His early work on duodenal lesions has not been surpassed up to the present time. It has been our good fortune to have followed Cole's

methods not blindly but judiciously we think, and to him we are indebted as well as are other workers for having learned to properly interpret the densities of the upper right abdominal quadrant as registered by the *x*-rays, not alone in duodenal lesions, but in our more recent efforts to interpret gall-stone shadows and the visualized gall-bladder itself.

The Anatomy of the Duodenum and its Relations.—An appreciation of the normal anatomy of the duodenum and its relations

Fig. 106.—Showing external surface of ulcer of anterior wall of the duodenum (W. J. Mayo).

is necessary for proper perspective. "The duodenum was originally named so because its length was supposed to correspond to the breadth of twelve fingers placed side by side. Its shape is approximately that of a horseshoe, the concavity toward the left accommodating the head of the pancreas. It commences at the pylorus and extends to the duodenojejunal flexure.

It may be divided into a superior portion, a descending portion, and an inferior portion. The superior portion is the first part of the duodenum and runs almost directly from before backward to become continuous with the nearly vertical de-

scending portion at the superior duodenal flexure. The inferior duodenal flexure connects the descending with the inferior portion, the upper portion of the latter being almost horizontal and forming what is sometimes termed the horizontal portion of the gut, while its termination bends upward and to the left, forming the ascending portion.

Fig. 107.—Normal stomach.

The relations of the duodenum are somewhat complicated. It is in contact with the following organs: the stomach and gall-bladder (superior portion), the liver (superior and descending portion), the pancreas (concavity of the descending portion), the inferior vena cava, the right kidney and suprarenal body (descending portion). The inferior portion lies in front of the vertebral column and aorta and behind the root of the mesentery. The superior and shortest portion is the only part of the

duodenum which is situated directly behind the abdominal anterior wall as the direct continuation of the stomach, the descending portion being concealed by the transverse colon and the inferior portion being in contact with the posterior abdominal wall behind the mesentery. The superior mesenteric vessels pass in front of the inferior portion, and the portal vein, arising behind the head of the pancreas, is posterior to the superior portion.

In general, the duodenum presents the typical characteristics of the small intestine, and especially those of the jejunum, its

Fig. 108.—Normal stomach, lateral view.

peculiarities, in addition to its situation and relation to the peritoneum, being as follows: its superior portion has no valvulæ conniventes, as these do not make their appearance until the superior duodenal flexure is reached; in the submucosa of this superior portion, however, large numbers of duodenal (Brunner's) glands occur. . . . The descending portion contains the orifices of the common bile-duct and of the pancreatic duct. . . . Both ducts usually unite shortly before their termination, causing a slight elevation characterized by delicate folds of mucous mem-

brane, the duodenal diverticulum (diverticulum of Vater). With the exception of its position and relations to the peritoneum the inferior portion of the duodenum differs in no respect from the jejunum, into which it passes without demarcation at the duodenojejunal flexure. The layers of the duodenal wall are similar to those of the small intestine in general (Sobotta and McMurrich).

Duodenal Ulcer.—Since 95 per cent. of all duodenal ulcers are found in the first or superior portion of the duodenum, the diagnosis of duodenal ulcer by the Roentgen ray is now the simplest procedure of any connected with the diagnosis of the pathology of the upper right abdominal quadrant provided one will follow what we have been pleased to call the direct method.

It offers no particular difficulty other than care in technic because it is based upon the following proved data: Anatomically the first portion of the duodenum is a constant entity which can always be demonstrated on an *x*-ray plate with characteristic shape and outline without exception if it is normal. Any constant defect in contour means a pathologic condition.

The direct method is opposed to the conception of the symptom complex of the European school which emphasizes inferential evidence. In the direct method no little effort must be made to show the anatomic condition of the first portion of the duodenum. No set rule can be laid down as to how this can be accomplished. Plates should be made with the patient in the prone position first, and in the majority of cases the first portion of the duodenum should be visualized readily, its borders appearing smooth and without contractures, in general appearance not unlike a bishop's miter.

In the average case it is simple, but occasionally spasm of the pylorus, pressure from adjacent viscera, and pathologic conditions, as gall-stones, diseased gall-bladder, and reflexes from a chronically diseased appendix will be the cause of an imperfectly filled or deformed duodenal bulb.

Whenever such is the case the examination must be carried over a sufficient period of time to satisfy one's self that the bulb has had time in which to fill. Most important of all, the patient

should be examined on the right side and a view of the duodenum obtained in this position. If one does not meet with success by this maneuver, then visualization of the first portion must be tried with the patient upright.

If the first portion of the duodenum cannot be outlined in its entirety in any of these positions, one may safely assume pathology; for if it be admitted that with a series of plates a normal duodenal bulb can be shown when it is normal, then the converse of the proposition must be true.

Fig. 109.—Chronic ulcer of the duodenum.

Many duodenal ulcers at operation have been demonstrated as mere mucosal defects, so that some workers were disinclined to believe the deformity of the duodenal bulb as pointed out by Cole and ourselves could be indicative of such mucosal erosions. It is now recognized, however, that in this type of ulcer the amount of callus in the submucosal, muscular, and peritoneal coats belies the mucosal defect itself, which accounts for the roentgenographic appearance of these ulcers, which seems exaggerated in comparison with the operative findings. In no other part of the gastro-intestinal tract is the deforming effect

produced by scar-tissue upon the opaque mass so marked as in the first portion of the duodenum.

In many cases on the Roentgen plate opposite the ulcer will be seen an incisura partly spastic in character, partly due to the involvement of the deep muscle layers by cicatrix. The pitfall for the novice in the Roentgen study of the duodenum is the differentiation of the deformity due to ulcer from that due to adhesions. Differentiation can be made readily between simple

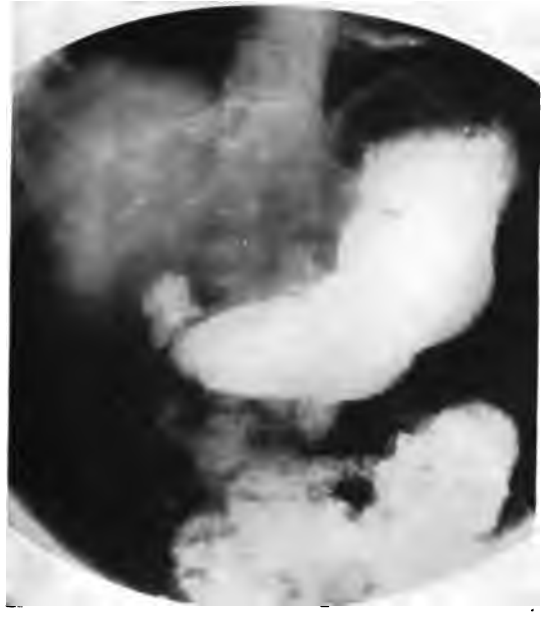


Fig. 110.—Chronic ulcer of the duodenum.

adhesions and ulcer. But where one finds a combination of ulcer and adhesions one cannot say always, nor is it necessary, whether these adhesions are due to the ulcer or to gall-bladder disease, or to both. It is sufficient to pass the opinion that there is a surgical lesion.

In simple adhesions the deformity of the opaque mass will be found to be greater at the beginning of the examination, decreasing as the stomach empties, and while the stomach when first filled will be found drawn over to the subhepatic region,

Fig 111

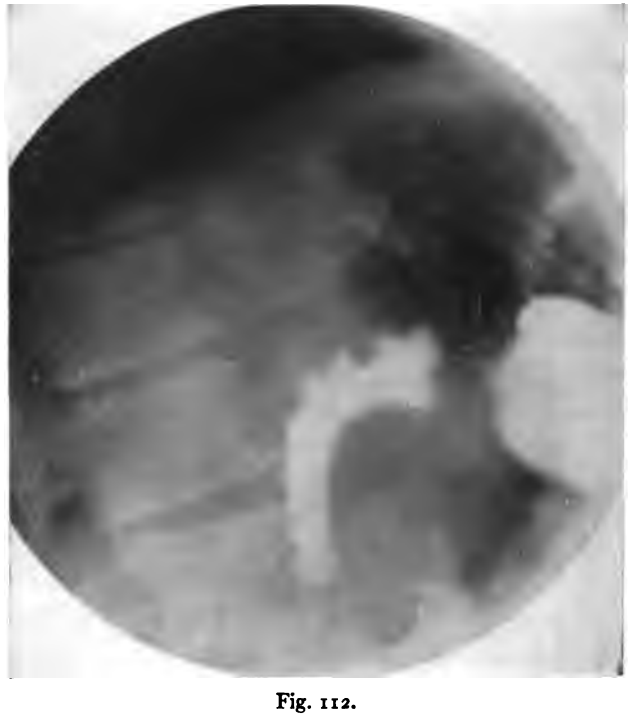


Fig. 112.

Fig. 113.

Fig. 114.

Figs. 111–114.—Chronic ulcer of the duodenum, lateral view. Figures 113 and 114, made six months after Figs. 111 and 112, show increase in the amount of scar tissue about the first portion of the duodenum.

successive plates will demonstrate it moving back to the median line as it empties. When the degree of deformity remains the same from the beginning of the examination until the stomach has almost emptied itself it is more characteristic of ulcer. A constant deformity of the duodenum is peculiar to ulcer and to no other lesion.

That a normal first portion of the duodenum rules out surgical ulcer increases many times the negative value of a Roentgen diagnosis by serial plates. Whenever we demonstrate the first portion of the duodenum to be free from deformity we pass a negative opinion. Once only in our experience was our opinion unconfirmed at operation up to date. Much of the usefulness of roentgenologic examination depends upon this negative aspect.

We find, then, that the Roentgen diagnosis of duodenal ulcer by the direct method basically rests upon the demonstration by serial plates of the continuity of the first portion of the duodenum or the demonstration of a constant defect in its contour. There is no better argument for the plate method than that this can be accomplished unfailingly with a careful and exact technic.

The roentgenoscopic or indirect method when applied to the study of the duodenum is entirely unsatisfactory. It is true that occasionally the duodenum can be seen in its entirety, but it can never be seen for a long enough time to satisfy one as to its anatomic completeness. It certainly cannot be shown in all cases, especially in well-nourished individuals. Furthermore, in the standing position in which the roentgenoscope is ordinarily used this demonstration is usually impossible. We do not mean to infer that the roentgenoscopic study of the gastro-intestinal tract is worthless. The roentgenoscope has undoubtedly its use in the study of the stomach and the large bowel. In the study of the duodenum and, much more so, the gall-bladder the roentgenoscope must really be considered as of minor value. The plate method is a more tedious process than the roentgenoscopic method, but the accurate results obtained by the former outweigh any other consideration.

The *second portion of the duodenum*, as seen with the use of

the barium buttermilk meal, is about the width of the adult thumb and does not show on the Roentgen plate the smooth contour of the bulbus duodeni, but rather a characteristic serrated appearance due to the valvulæ conniventes. Occasionally it is dilated to a greater width than this, which may be merely anatomic. When dilated to any considerable degree it is always due to obstruction somewhere beyond the second portion. Rarely have we found the constriction of the second portion of the duodenum to be due to gall-bladder adhesions, though the lumen may be considerably narrowed by adhesions. In the case of adhesions, however, the function of the second portion of the duodenum is not altered so far as the passage of the opaque meal is concerned.

We have found the second portion of the duodenum of chief interest as a very important diagnostic sign in the study of gall-bladder disease. It may be the only evidence by which we can exactly localize the size and shape of the gall-bladder. We have frequently found the second portion of the duodenum picked up, as it were, by adhesions to the gall-bladder, so that the gall-bladder outline could be distinctly made out by this relation. When the descending or second portion of the duodenum instead of passing directly downward is seen to pass outward toward the liver border, then curve to its normal position, this may be considered almost pathognomonic of gall-bladder disease.

A sign of secondary importance described by a few observers is the filling of the ampulla of Vater by the opaque medium. It does not occur commonly, and may indicate disease of the gall-bladder, the assumption being that if the opaque meal enters the ampulla and is retained there for any reasonable length of time, so may food, and if such food is retained, there is a very definite potential danger of ascending infection of the gall-bladder.

The Gall-bladder.—The text-books on anatomy locate the gall-bladder in a fairly definite and constant position. We have found, however, from a study of our plates, which without question show the gall-bladder shadow, that the gall-bladder may be

found most anywhere on the right side below the diaphragm. We have seen it apparently lying over the spine in the median line, toward the outer side in the right flank, and even below the crest of the ilium almost in the true pelvis.

It must be borne in mind that a large percentage of gall-bladders have a distinct mesentery of their own which allows considerable latitude in movement. The anatomists are inclined to give the contrary impression that the gall-bladder is adherent to the under surface of the liver and firmly fixed.

Fig. 115.—Group of gall-stones.

The size of the gall-bladder shadow as we see it is also a variable factor. In the dissecting room the apparently normal gall-bladder is about 1 inch in diameter and 2 to 3 inches in length. The Roentgen shadow of demonstrated gall-bladders varies from the size of an olive to the size of a grape-fruit, as in hydrops.

The visualized gall-bladder is roughly pear shaped, the most constant feature being the characteristic curve of the lower pole.

The inner edge of the shadow is usually distinct. This fact is a help in differentiating between a gall-bladder and a kidney shadow.

Fig. 116.—Group of gall-stones.

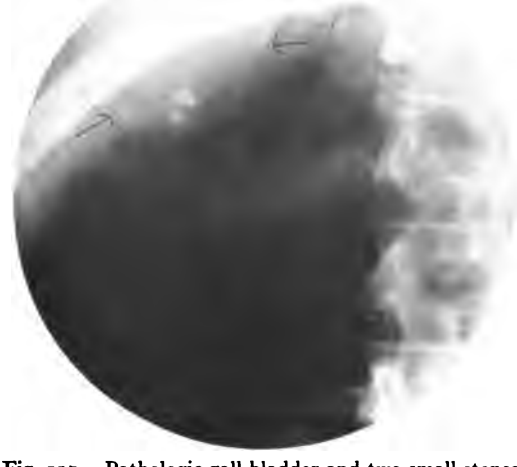


Fig. 117.—Pathologic gall-bladder and two small stones.

As a result of our observations we have assumed as a working hypothesis that only when some pathologic change has taken place either in the walls of the gall-bladder or its contents can

its shadow be demonstrated on the *x*-ray plate. We also assume the converse that for practical purposes the shadow of a normal gall-bladder cannot be demonstrated.

The diagnosis of gall-stones by the Roentgen ray we simply mention here for completeness, and to show its relation to our later work in the diagnosis of gall-bladder disease without stones.

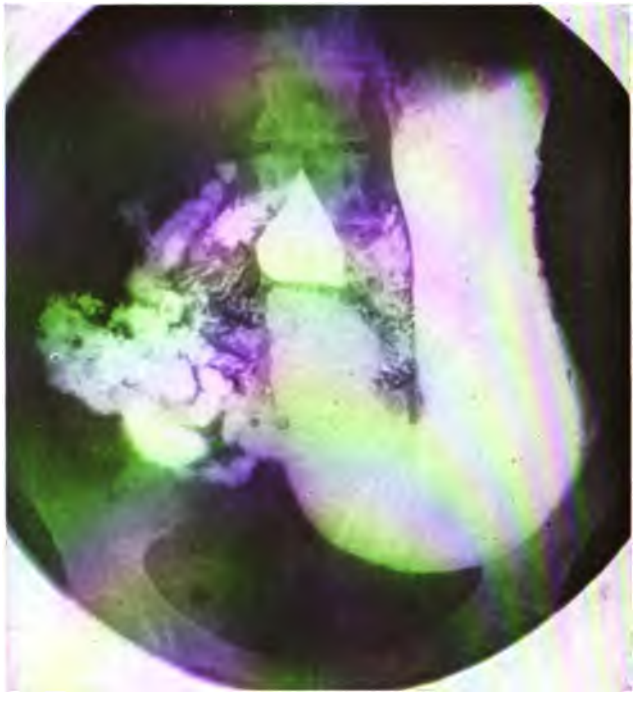


Fig. 118.—A group of stones with more or less fixation of the small bowel about the gall-bladder, and with marked ptosis of the stomach.

Our conclusions reached in 1915 and reported at length at that time we have not yet found it necessary to change, in effect that with proper technic gall-stones can be demonstrated by the *x*-ray whenever present. Stones containing calcium may be demonstrated with ease, while the so-called soft stones can be demonstrated with care.

While perfecting the technic and our methods of gall-stone diagnosis, we were led to use the term "suspicious shadows"

in reporting our results in cases where we recognized changes in densities in the plate not definite enough to warrant a positive diagnosis of gall-stones and yet preventing an absolutely negative opinion.

This term "suspicious shadows" aroused a great deal of adverse criticism from our colleagues, on the ground that it was elusive and perhaps a dangerous phrase to use.

Fig. 119.—Outline of gall-bl.ader filled with calcified crystals. Note the "picking up" of the hepatic flexure by adhesions.

As a result of our endeavor to interpret properly the significance of these so-called "suspicious shadows" has come forth our conviction that the gall-bladder can when pathologic, and then only, be demonstrated by the *x*-rays.

We early observed that in the majority of instances these shadows or changes in density were not due to gall-stones, but rather were shadows from organs occupying the right upper quadrant, as the quadrate or caudate lobes of the liver, gall-

bladder, upper pole of the kidney, adrenal gland, and food-filled duodenum or stomach antrum. By repeated examinations of the upper right abdominal quadrant with the subject fasting, with the stomach and duodenum barium filled, and by persistent study of kidney plates we were able to differentiate these sus-

Fig. 120.—Pressure of the gall-bladder on first portion of the duodenum.

picious shadows. Bearing in mind the appearance of the gall-bladder in cases with self-evident stones also aided in demonstrating the characteristic density which we now interpret as the pathologic gall-bladder.

By "pathologic" we mean either the walls of the gall-bladder are thickened or the bile content is of greater density than nor-

mal, or greater in quantity, or it contains stones or foreign material of some sort. Furthermore, there may be changes in the circulation, congestion in blood-vessels, or unknown alterations which singly or in combination are sufficient to make a visible contrast between the gall-bladder shadow and the shadow of surrounding tissues.

Let it be borne in mind that we offer this simply as a working hypothesis. Thus far, judging from our operated cases, we consider it a safe and reliable diagnostic aid. We shall gladly

Fig. 121.—Pathologic gall-bladder without stones.

admit the unreliability of this hypothesis once it is demonstrated that the normal gall-bladder can be visualized.

To declare that a normal gall-bladder can be visualized and offer in proof of it that cases have come to operation wherein the surgeon has passed the opinion that the gall-bladder was normal, can hardly obtain our serious thought.

We are sure it has been the experience of every busy surgeon that on more than one occasion he has failed to detect sizable gall-stones within the gall-bladder on mere palpation. Nor do we believe that any surgeon of note today would declare that

no pathology was present in a gall-bladder because on inspection no gross disease was recognized.

So when claims are made that the normal gall-bladder can be shown on the plate we shall deem such worthy of attention when accompanied by a negative report from the pathologist, for only by removal of the gall-bladder and subjecting it to a

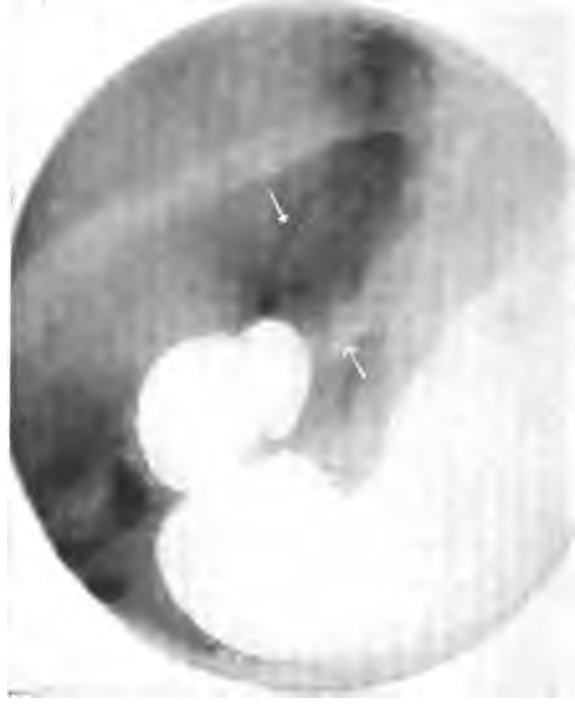


Fig. 122.—Pathologic gall-bladder without stones.

microscopic examination can the absence of disease be ascertained.

Some Roentgen workers claim to have visualized the gall-bladder in normal healthy individuals, to which we answer that as a certain number of "normal" individuals may show gall-stones, so too any series of "healthy" persons will unquestionably have technically pathologic gall-bladders without clinical symptoms. In these cases the bile may be slightly abnormal

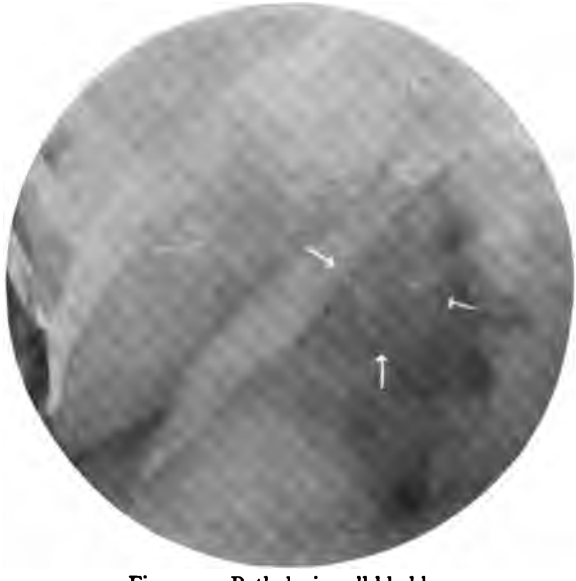
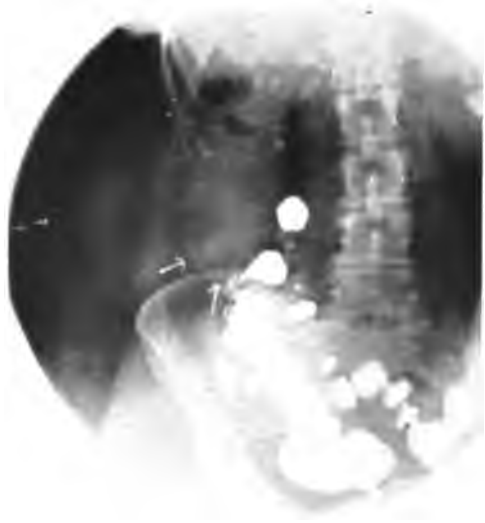


Fig. 123.—Pathologic gall-bladder.

Fig. 124.—Pathologic gall-bladder without stones.

in consistency or there may be changes in the gall-bladder walls due to some old typhoid, streptococcus, or colon infection of the gall-bladder long since forgotten.



F.g. 125.—Hydrops gall-bladder.

Fig. 126.—Pathologic gall-bladder with marked adhesions about the second portion of the duodenum.

It is clear, therefore, that any experimental work done on a series of "ordinarily healthy" individuals to prove the possi-

bility of the Roentgen demonstration of the normal gall-bladder is to no purpose. Furthermore, a certain amount of work has been done upon the cadaver tending to prove the fallacy of our hypothesis, but roentgenologists of any experience know that results obtained in the Roentgen examination of the dead cannot be translated to the living, so that we consider such work worthless as far as offering any aid in the solution of the problem is concerned.

Fig. 127.—Pathologic gall-bladder with "picking up" of hepatic flexure by adhesions.

We do not question the possibility that the time may arrive when the normal gall-bladder will be demonstrated on the *x*-ray plate. Meanwhile we believe we have found a satisfactory working hypothesis substantiated by our experience and rational in its theory.

Technic.—The first requisite for a proper Roentgen examination in suspected gall-bladder disease is that the patient be examined when fasting. And it is further important that the patient should not have eaten a solid meal or, in fact, have

taken too much liquid within six hours, for food or liquid in either the first or second portion of the duodenum is apt to give

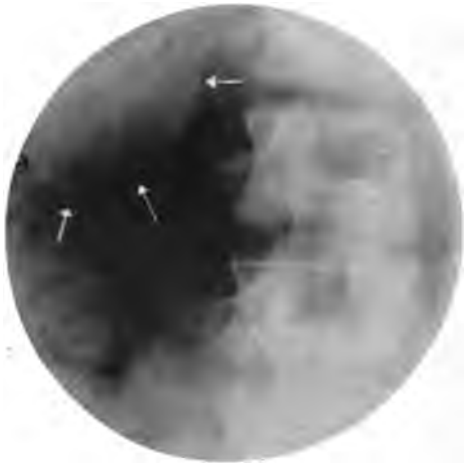


Fig. 128.—Pathologic gall-bladder containing one large stone.

Fig. 129.—Same case as Fig. 128 Plate made after removal of gall-bladder.

rise to confusing densities on the plate. The patient should be examined prone, lying face downward on the table, with the

plate or intensifying screen and plate beneath so arranged that the costal margin will bisect the middle portion of it.

A small cylinder and diaphragm preferably of the size supplied by the Kelley-Ket Company for frontal sinus work should be employed, and so arranged above that the costal margin bisects the area of the cone. The distance of the tube from the plate is not of the utmost importance. We find that using the

Fig. 130.—Pathologic gall-bladder "picking up" the hepatic flexure.

cone 3 or 4 inches above the back of the patient appears to help in giving a larger and clearer image. The exposure and its intensity must vary with the individual patient. Not the least important thing is to make a sufficient number of plates with the patient in the one position. It is a mistake to try to distort the shadows in the upper right abdominal quadrant. Plates should be developed as they are taken, and studied while in

development as well as when finished. We have found that in a great many cases the outline of the gall-bladder was seen during the development better than when the plate was completely fixed and dry.

We cannot insist too strongly on the matter of making a sufficient number of plates in the one position and with the

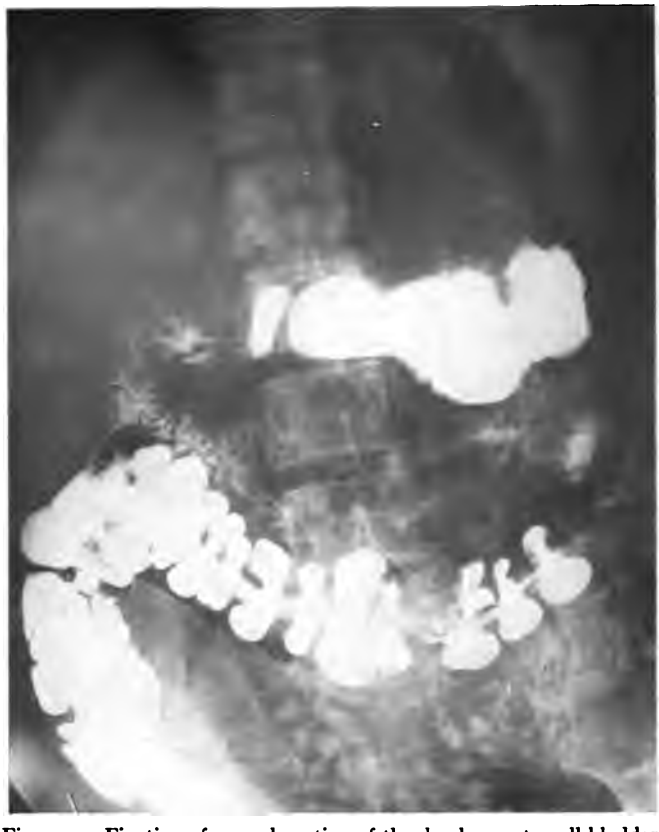


Fig. 131.—Fixation of second portion of the duodenum to gall-bladder.

gastro-intestinal tract empty. In fact, we feel that the reason other workers have not had the success which we believe possible is due to this very fact. This will explain especially, we believe, the failure in hospital clinics as opposed to private work. The technic just described is quite as necessary and important for

the diagnosis of gall-stones as for any other suspected pathologic condition of the gall-bladder.

We have made this technic just described a routine measure in all gastro-intestinal cases sent to us for diagnosis. Once we have determined as much about the right upper quadrant as we feel we can in this manner, the patient is then given the barium-buttermilk meal for visualization of the gastro-intestinal tract. Following the direct and indirect examinations of the stomach

Fig. 132.—Hydrops of gall-bladder with one stone in cystic duct.

we then pay particular attention to the barium-filled duodenum in relation to the densities seen in the upper right quadrant, and still again in the six-hour and twenty-four-hour examination of the bowel, for we have found that we often obtain valuable signs pointing to gall-bladder disease at these times. It should be here recalled what we have said above, that the gall-bladder may be found almost anywhere to the right of the median line below the diaphragm, and hence in occasional cases search will have to be made for it in other than its usually given location.

The Large and Small Bowel.—In conclusion, we desire to call attention to a recent observation we have made in gall-bladder disease suggested by the transposition of the jejunum to the upper right quadrant. In gall-bladder disease considerably more gas will be found in plates made of the upper right quadrant than is seen normally, and a careful study of the plates will reveal the fact that this may be in the small bowel (jejunum)

Fig. 133.—Gall-bladder after removal.

rather than in the hepatic flexure or transverse colon. This observation must be checked up by comparison of the plates made before and after taking the barium meal. The appearance of the gas-filled hepatic flexure and transverse colon as seen in the six- and twenty-four-hour plates made following the barium meal is quite characteristic in gall-bladder disease. It appears on the plate like a sacculation of gas with a faintly limned periphery of barium just above which or impinging upon it can be seen the visualized gall-bladder.

While the diagnosis of duodenal ulcer has now passed without the realm of controversy, not so the value of Roentgen evidence in gall-bladder disease, but just as the early work of Cole and ourselves on duodenal ulcer was severely questioned, only ultimately to be accepted, so we feel that our present position on the evidence of gall-bladder pathology is based on scientific grounds, and will be accepted as such.

CLINIC OF DR. JOHN B. HAWES, 2D

MASSACHUSETTS GENERAL HOSPITAL

EARLY DIAGNOSIS OF PULMONARY TUBERCULOSIS

The Need of Diagnostic Standards in the Early Diagnosis of Tuberculosis. Importance of the History and Constitutional Signs and Symptoms as Compared with Those Referred to the Lungs. Definitions of Certain Terms. The Need of Thoroughness and Especially Common Sense.

December 17, 1917.

DESPITE the activity and efficiency of the campaign against it, our tuberculosis problem is still with us. The present war has brought to light many hitherto unsuspected cases, while, in addition, the stigma of tuberculosis has been cast on not a few who later turn out to be suffering from something else. Tuberculosis in some form or other and problems connected with it constitute a large part of the work of every physician who does general practice, and no such physician can do justice to his patient or to himself unless he is able to diagnose tuberculosis in its early stages. There is urgent need, therefore, especially at the present time for us to formulate and, if possible, standardize our ideas as to the early diagnosis of this disease.

To many physicians any such standardization may seem quite unnecessary. Just as the diagnosis of malaria is based on the finding of the plasmodium in the blood, and that of typhoid fever on a positive Widal reaction or blood-culture, so the early diagnosis of tuberculosis is based on certain combinations of signs and symptoms. These, without the slightest hesitation, any physician or, indeed, medical student would enumerate somewhat as follows:

1. Family and personal history.
2. History of exposure.

3. Constitutional signs and symptoms, such as—
   (*a*) Loss of weight.
   (*b*) Loss of strength.
   (*c*) Fever.
   (*d*) Rapid pulse, etc.
4. Local signs and symptoms referred to the lungs or the chest, such as—
   (*a*) Hemorrhage.
   (*b*) Pain or pleurisy.
   (*c*) Cough and sputum.
   (*d*) Dulness, altered voice and breath sounds, râles, etc.

It is very easy to formulate such a list as this of the signs and symptoms on which a positive diagnosis may be based. On more careful analysis, however, one is immediately confronted by the fact that there is a tremendous difference of opinion as to what these terms, such as "fever," "hemorrhage," etc., really mean, and on what combination of signs and symptoms a positive diagnosis in the absence of tubercle bacilli in the sputum should be based. One group of men will demand certain signs in the chest without which no diagnosis should be made; other physicians believe that a careful study of constitutional signs and symptoms will bring about more accurate results, even if there are few or no abnormal signs in the lungs; a third group of physicians depends on *x*-ray evidence, while a fourth group puts reliance on tuberculin tests, etc.

Again, referring to the signs and symptoms themselves, ask any twelve physicians what each one means by the word "hemorrhage," and you will be apt to get a dozen different answers. Ask what constitutes "fever" or "rapid pulse," and no two will agree, or again, ask what "loss of weight and strength" means, and you will find the same variance in the answers. It is evident, therefore, that despite the need for this, there is at present no definite set of standards on which the early diagnosis of tuberculosis can be based, and it is likewise evident that any attempt at such standardization will be difficult.

Attention was recently focussed on this subject in carrying on the tuberculosis experiment in Framingham, Massachusetts.

This "experiment," now well known as a "Community Health and Tuberculosis Demonstration," has been financed by the Metropolitan Life Insurance Company of New York for a three-year period, and is being conducted under the supervision of the National Association for the Study and Prevention of Tuberculosis. One of the first difficulties that Dr. Donald Armstrong, the executive officer, and Dr. P. C. Bartlett, his medical director, met was in regard to this question of early diagnosis. There was no consensus of opinion among the physicians of Framingham as to what constituted sufficient evidence for a positive diagnosis. Consequently, a committee of Boston physicians was asked to prepare a set of standards for this purpose. In formulating a draft of such standards, which I was asked to prepare for this committee, I at once found it necessary to define certain terms mentioned above, such as "hemorrhage," "fever," "loss of weight," etc.

The following cases illustrate the various combinations of signs and symptoms on which a definite diagnosis may justly be based. In connection with them I will discuss the definitions and diagnostic standards adopted for the purposes of the Framingham Experiment.

DIAGNOSIS BASED ON HEMORRHAGE

CASE 1.—This man, thirty-five years old, previously healthy, had been feeling perfectly well, when he suddenly had a fairly profuse hemorrhage of 2 or 3 tablespoonfuls of blood. His family and personal history are negative, and there is little to be found in the lungs. I have told him that beyond the slightest doubt the hemorrhage was due to tuberculosis and that he must keep very closely under my supervision. I hope to persuade him to go to a sanatorium for a while at least.

In this case there has been a frank and definite pulmonary hemorrhage, and the diagnosis of tuberculosis is absolutely justified even if the signs in the lungs are very slight and the sputum negative.

CASE 2.—This patient comes to the clinic because she has had frequent small hemorrhages. She has seen many doctors in

New York and Philadelphia and has been told that she has consumption. Her general condition is excellent, and I can hear nothing abnormal in the lungs. Her teeth are in very poor condition, the gums spongy, with marked evidence of Rigg's disease. On careful inquiry I found that the so-called "hemorrhages" consist of minute spots or streaks of blood, never as much as a teaspoonful. I have advised her to go to a good dentist to have her teeth attended to and her gums treated. This she did some time ago, since which time the hemorrhages have ceased.

Here the patient had what she called a "hemorrhage" and repeated ones. Impression had been given her that she had consumption, on account of which she has been put to much unnecessary expense and anxiety.

CASE 3.—A few weeks ago this patient, a strong, robust Irish girl, weighing over 160 pounds and the picture of health, came to see me because for a great many years at frequent periods throughout the year she has raised blood in considerable amounts up to 1 or 2 tablespoonfuls. The last hemorrhage was three weeks ago. In taking her history, her mother told me that when a young girl she had swallowed a stick-pin and that she had never been able to recover it. On examination I found very little in the lungs, no râles, and few other abnormalities, but on account of this history of having swallowed a stick-pin, which I thought might have gone into the lung instead of into the stomach, I have had an *x*-ray examination made. The plate clearly shows a foreign body at the base of the right lung, but also suspicious shadows at the left apex. This girl is in perfectly good condition and has simply been worried on account of the hemorrhages.

This is a difficult proposition. Constitutional signs and symptoms are absolutely lacking, and yet there is this history of repeated hemorrhages. Perhaps there is an inactive tuberculous process at the left apex in addition to the inflammatory changes set up around the foreign body, although I can hear no râles or other signs of activity. It seems to me that the burden of proof, however, is distinctly on anyone who maintains that this patient is at present suffering from active pulmonary tuberculosis.

These 3 cases show how indefinite a term is the word "hemorrhage." The definition adopted by our committee is as follows:

> "Any amount of expectorated blood, with or without sputum, requires medical investigation as to its source. Blood-streaks, blood-spots, etc., may or may not mean tuberculosis. On the other hand, a hemorrhage of 1 or 2 teaspoonfuls is presumptive evidence of the disease."

This definition seems to me sane and sound and one that might well be universally adopted.

DIAGNOSIS BASED ON CONSTITUTIONAL SIGNS AND SYMPTOMS

CASE 4.—This woman is a nurse, thirty years old, and she comes to the clinic on account of loss of weight and strength and because she is not able to do her work as well as she could a year ago. She has a slight cough, but no sputum. Temperature and pulse are normal. She weighs 120 pounds, which is 18 pounds less than what she weighed six months ago. In the lungs I find nothing but a "suspicious right apex." There are a few other suspicious signs and symptoms. I have told her that I believe that she has incipient tuberculosis and that she must report regularly to me every two weeks and be prepared to go to a sanatorium unless she improves.

The striking point in this case is loss of weight and strength, but here, again, we are using terms that need some sharp definition. What may constitute "loss of weight" in its pathologic sense to one person may mean something entirely different to another.

Our definitions of these two terms are as follows:

> "Loss of Weight: By 'loss of weight' should be understood an unexplained loss of at least 5 per cent. below normal limits for that particular individual within four months' time."
>
> "Loss of Strength: By 'loss of strength,' in its pathologic sense, is meant undue fatigue and a lack of staying power which are unusual for the individual patient and which cannot be satisfactorily explained."

These definitions may require some modification to meet individual cases. On the whole, however, they seem to be working out fairly satisfactorily in Massachusetts.

DIAGNOSIS BASED ON FEVER AND RAPID PULSE

CASE 5.—This man, who is twenty-seven years old, is sent to me for examination by his employer. His family and personal history are not very remarkable, but suggest tuberculosis. The examination of the lungs shows comparatively little. The temperature and pulse, however, taken quietly four times a day at home over a period of three or four days show a slight afternoon fever and a pulse averaging 90. This fever and rapid pulse in combination with other signs and symptoms justify me in making a definite diagnosis. His chart is as follows:

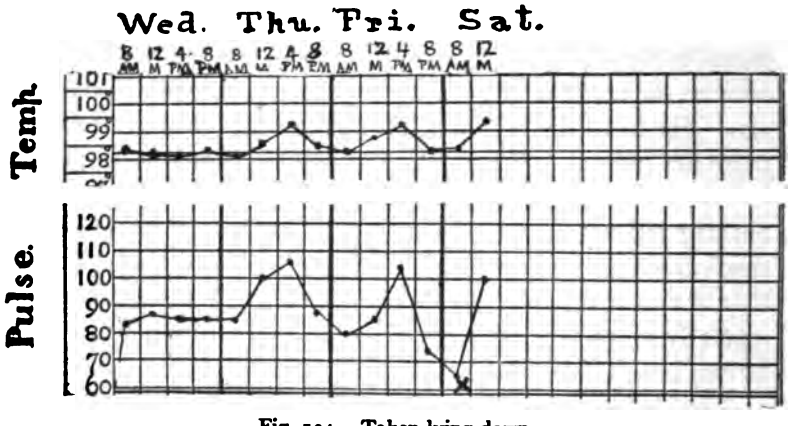


Fig. 134.—Taken lying down.

I cannot emphasize the importance of such a combination as this—slight fever and rapid pulse. It *may* not mean tuberculosis, but in many cases it certainly does.

CASE 6.—This young man, a draftsman of twenty-two, comes to the clinic because he has had a cough off and on for a year, and especially because he has lost weight and strength, and in other ways does not feel as well as he thinks he should. He is evidently an intensely nervous person. At my first examination he had a temperature of 100° F. and a pulse of 122. Aside from this I could find very little abnormal. I told him to take his temperature and pulse four times a day at home, which he did. The pulse ranged from 60 to 70, and the temperature was constantly normal. Backed up by this evidence I am prepared to tell him

definitely that I do not believe that he has active pulmonary tuberculosis.

In this instance the patient complains of loss of weight and strength and other constitutional symptoms. The fever and rapid pulse at his first examination at the clinic are not more than that of many patients of a nervous temperament under similar circumstances. I consider the normal temperature and slow pulse taken at home to be evidence that more than counterbalances the history of cough and slight loss of weight and other symptoms of which this patient complains.

Our definition of fever and elevation of pulse as illustrated by these cases is as follows:

> "Fever: An occasional temperature of 99° F. should not be considered 'fever.' A temperature which persistently runs over 99° F. when taken at least four times a day over a period of one week (by mouth, five minutes) should be considered of significance and to constitute 'fever'."
>
> "Elevation of Pulse: Where the average normal pulse of the patient is already known, an elevation of 15 beats per minute when the pulse is taken quietly at home during various periods of the day should be considered abnormal. In cases where the average pulse is not known, and, of course, this constitutes the majority of cases, one should consider an average pulse of 85 or over in men and 90 or over in women to be abnormal. The combination of a subnormal temperature and an elevated pulse as defined here should be considered of great importance."

I have found these definitions helpful to me in my work in closely limiting what were before loose and indefinite terms.

DIAGNOSIS BASED ON FAMILY HISTORY AND EXPOSURE

It is unnecessary to cite cases illustrating these points. There is urgent need, however, of sanity in weighing such evidence. Because an uncle, aunt, grandparent, or cousin has died of consumption does not mean that the patient in question must have it or has even been exposed to it. On the other hand, many of our "New England winter coughs" in elderly persons on close investigation turn out to be chronic phthisis and explain the incidence of tuberculosis in grandchildren and others in the family.

Again, the physician may declare the family history to be absolutely negative as far as tuberculosis is concerned, and fail to elicit the fact that a nurse or attendant who later died of consumption cared for the patient when a child.

The following definitions of family history and exposure emphasize these points:

> "Family History: An occasional case of tuberculosis in the patient's uncles, aunts, cousins, etc., should not be considered of importance. It is an important fact when the patient's immediate relatives, such as brothers, sisters, father, mother, or grandparents, have been tuberculous."
>
> "Exposure: Childhood exposure is of the greatest importance. Moderate exposure among normal, healthy adults of cleanly habits is of less importance. Of course, prolonged contact, with unhygienic habits or surroundings, may be a dangerous factor at any age."

DIAGNOSIS BASED ON SIGNS AND SYMPTOMS REFERRED TO THE CHEST OR LUNGS

CASE 7.—This patient, a woman of thirty, has been referred to me by a physician in another city because of persistent râles at the left apex. These were found on a routine examination, neither patient nor her physician suspecting the presence of tuberculosis. On careful inquiry I found that she has never been particularly strong or robust, but except for this and the presence of persistent râles I could discover very little else that was suggestive of tuberculosis either in the history or the physical examination. The râles have remained, however, on repeated examinations.

In this case the family and personal history were negative or nearly so. Constitutional signs and symptoms as defined above were not more marked than could be explained by nervous exhaustion and physical fatigue, but there was a slight—though very slight—cough, some sputum persistently negative, and definite, *persistent râles* at the left apex. On this evidence I am quite ready to make a definite diagnosis of incipient pulmonary tuberculosis.

CASE 8.—This young man is twenty-four years old, is over 6 feet in height, and weighs nearly 200 pounds; he comes to see me because he has been told that he has tuberculosis. His family and

his own history are practically negative. There is a slight cough, with some sputum. Physical examination shows dulness over the upper third of the right lung, with numerous crackling râles in front and back. These râles have persisted on several examinations.

This man is of the type that many physicians would at once dismiss from their office with the words, "Why, you are the picture of health! You simply can't have tuberculosis!" Nevertheless he does have tuberculosis, although his history does not suggest it and constitutional signs and symptoms are nearly absent. It is important to note that the persistent râles in this case and in the preceding one were at an apex and not at the base of the lung. Had the râles been at the base of the lung in either case I would have made an entirely different diagnosis. We have called attention to this in our diagnostic standards as follows:

> "Usually a process at the apices should be considered tuberculous, and a process at the base to be non-tuberculous, until the contrary is proved, excepting when a clear history of pleurisy is present."

The relationship of constitutional signs and symptoms to those in the lungs as illustrated in these cases is referred to as follows:

> "1. When constitutional signs and symptoms and definite past history are absent or nearly so, there should be demanded definite signs in the lungs, including persistent râles at one or both apices. By 'persistent' it is meant that the râles must be present after cough at two or more examinations, the patient having been under observation at least one month.
>
> "2. In the presence of constitutional signs and symptoms, such as loss of weight and strength, etc., as defined above, there should be demanded some abnormality in the lungs, but not necessarily râles."

DIAGNOSIS BASED ON PLEURISY WITH EFFUSION

CASE 9.—This young man, aged twenty-seven, apparently strong and robust, came to the clinic on account of increasing shortness of breath. He had a pain in the left side of his chest at first, which has since disappeared. There were evident signs of a large amount of fluid in the left pleural cavity. I sent him into the hospital at once, where his chest was tapped and 40

ounces of clear straw-colored fluid removed. A few râles were found at the right apex. Temperature and pulse are now normal. I have explained the exact situation to this man, that pleurisy is a mild form of tuberculosis, and that he must report to me every week for several months.

Until comparatively recently a case of pleurisy with effusion was treated purely as such, the fluid was drawn off if necessary, and little or no attention was paid to the tuberculous process that practically always lies in the background. It is not always easy to decide whether a patient with pleurisy with effusion should or should not be put under strict sanatorium régime. In my own cases I base my decision on the following points:

1. Whether or not there are constitutional signs and symptoms of a tuberculous toxemia, as defined above.

2. Whether or not there is any evidence of any intrapulmonary involvement at the apices or elsewhere.

At all events every case of pleurisy with effusion should be kept under observation for a few months at least, and the following statement concerning this in the diagnostic standards borne in mind:

> "One should consider a typical pleurisy with effusion as presumptive evidence of tuberculosis."

Likewise not only applicable to pleurisy with effusion but also to all of these cases is the following:

> "In every doubtful case one should demand that the patient be kept under observation for at least one month, with repeated sputum examinations, before a definite diagnosis is made."

AIDS TO DIAGNOSIS

Tuberculin Tests.—In children of fifteen years of age or under the von Pirquet cutaneous test is of great value in diagnosis, increasing in value as the age decreases. In adults it is of little or no significance. The subcutaneous tuberculin test should not be used except by those experienced in its use and thoroughly aware of its possible dangers. As a general rule I advise against its use in suspected cases of pulmonary tuberculosis. The com-

plement-fixation test is still in the experimental stage and is not yet available for general practitioners.

x-Ray.—An *x*-ray examination *may be* of great value as an aid to diagnosis. I use the phrase "may be of great value" advisedly. There are many hyperenthusiastic roentgenologists who claim that the *x*-ray will reveal tuberculous disease earlier and more accurately than can be done by any other method. It is undoubtedly true that the *x*-ray will reveal certain changes and abnormalities in the lung that cannot be detected in other ways, but it must always be remembered that *x*-ray evidence is based on lights and shadows, and that in most instances active and recent processes cannot be differentiated from inactive and old processes. Furthermore, the value of the *x*-ray plate, be it ever so clear and distinct, is dependent on the man who interprets the plate. It is true that *x*-ray evidence interpreted by an expert who recognizes the limitations as well as the possibilities of this method of diagnosis is of great value, but it is still more important to remember that such evidence should never take the place of a careful and painstaking history of the patient and the study of his constitutional symptoms and local signs in the lungs.

DIFFERENTIAL DIAGNOSIS

Non-tuberculous Acute and Chronic Pulmonary Infections.—In Massachusetts during the past year there has been what has almost amounted to an epidemic of acute and subacute infections of the lungs, many of which closely resemble and have been called cases of tuberculosis. In some instances an exact diagnosis of such a condition can be reached only by waiting. In the majority of cases, however, careful study will show that tuberculosis is unlikely. The chief points of difference are as follows:

1. These non-tuberculous processes are usually at the base of the lung, whereas in tuberculosis the disease is usually at the apex.

2. Despite extensive signs in the lungs, constitutional symptoms, especially fever and rapid pulse, are often absent or very slight.

3. Although there often is a large amount of purulent sputum, repeated examinations for tubercle bacilli are negative.

4. The fact that extensive signs in the lungs gradually clear up or disappear in the course of a few weeks or months.

Such cases are often not only very difficult to diagnose but also very difficult to manage. One must always bear in mind that tuberculosis may be present despite negative evidence; also, and of still more importance, that it is unjust to go to the other extreme and stamp the patient as a consumptive, as I regret to say is often done, on insufficient evidence. Conservative, sound common sense is urgently needed in such cases as these.

Other Causes of Blood Spitting.—Our definition in the diagnostic standards states that "A hemorrhage of one or two teaspoonfuls of blood is presumptive evidence of tuberculosis." This is a safe rule. Occasionally, however, there occur frank hemorrhages that do not mean tuberculosis. Elderly persons with high blood-pressure and sclerotic arteries may raise considerable amounts of blood due to a ruptured blood-vessel in no way connected with a tuberculous process, although I admit that this would be very difficult to prove. Often in mitral stenosis and other forms of heart disease and occasionally in bronchiectasis and pulmonary cancer there may be real hemorrhages as defined above. These possibilities should be borne in mind.

Early hyperthyroidism, or exophthalmic goiter, often cannot be differentiated at first from early pulmonary tuberculosis. Fortunately, the treatment is the same, and time will usually give the correct diagnosis.

Malignant Diseases of the Lung.—Here again the differential diagnosis may be impossible at first, but also, as in hyperthyroidism, this question will eventually settle itself.

Pulmonary syphilis doubtless does exist, but it is certainly very rare. The fact that a person has a positive Wassermann and other evidence of a luetic infection along with certain abnormalities in the lung, and the fact that such abnormalities clear up under antiluetic treatment does not necessarily prove that the changes in the lung are due to syphilis, nor that the case is one of pulmonary syphilis. On the other hand, when luetic infection is known to be present in combination with marked signs in the lungs out of proportion to the constitutional signs and symptoms,

and when these clear up under antisyphilitic treatment, pulmonary syphilis must certainly be very seriously considered.

Other Causes of "Being Run-down."—In Massachusetts the medical profession and the public are both wide awake to the need of the early diagnosis of tuberculosis. The younger members of the medical profession, in fact, are so alive to this that anyone who loses weight or who becomes run-down from whatsoever cause runs a very serious chance of falling into the hands of some enthusiastic doctor who promptly labels him a consumptive. While this state of affairs is obviously better than the condition that existed ten years ago, when very few physicians made a definite diagnosis of phthisis until the disease was in the advanced stages and the sputum positive, nevertheless it is a condition that ought not to exist. Anyone who makes a positive diagnosis of tuberculosis without a positive sputum is taking on himself a very grave responsibility. We must remember that people will continue to get tired out, to lose weight and strength, to have colds that hang on, and to need vacations without being consumptives. Granted that certain of these conditions are due to latent tuberculous processes which are in danger of being roused to activity, in doubtful cases there is no need of telling the patient that he is a consumptive and that he must go to a sanatorium on such slight evidence as this. Here again common sense is the physician's most valuable asset in handling such problems.

Finally, I would emphasize these points as strongly as I can —namely, that the early diagnosis of pulmonary tuberculosis is no easy task; that it takes time, patience, and thoroughness to make a correct diagnosis; that the patient's happiness, health, and often his life depend on the advice given by the physician at this time; that the physician should realize the responsibility he is assuming in making his decision one way or the other; and, finally, that success in this field depends more on the use of common sense than on any other quality the physician may possess.

CLINIC OF DR. FRANKLIN W. WHITE

BOSTON CITY HOSPITAL

IMPROVEMENTS IN THE DIAGNOSIS OF CHRONIC ULCER OF THE STOMACH AND DUODENUM

Modern Methods of Examination of Patient; Importance of Location and Size; Use of the Stomach-tube and the Roentgen Ray; Desirability of Roentgen Evidence in Contradistinction to Roentgen Diagnosis; Necessity of Watching the Ulcer Itself and Its Effect on the Functions of the Stomach, etc.; Late Diagnosis of the Condition of the Ulcer During and After Treatment.

THERE have been great changes in the last few years in the diagnosis of chronic peptic ulcer. We have recognized the imperfections of some of our older methods of examination, and laid more emphasis on newer ones. We are now able to locate ulcers, to measure their size, and to study more completely their effect on the functions of the stomach. We are much better able to classify these ulcers in groups for treatment and to choose the treatment best suited to the individual case.

We are now able to follow the ulcers in a new way during their course of treatment, whether medical or surgical, and to see what becomes of them, whether they are getting larger or smaller, not depending wholly on what the patient tells us about his feelings, but *watching the ulcer itself* from time to time and its effect on the functions of the stomach, and changing our treatment to meet the needs of the individual case.

There are great advantages in this method by direct observation of the ulcer and the progress of healing by the Roentgen ray; it helps greatly in deciding for and against surgery. By directly observing the patient we can best protect him from the develop-

ment of cancer and make an actual, *early* diagnosis of secondary cancer and make a life-saving operation possible.

History.—I shall pass over rather briefly the use of symptoms in diagnosis, not because it is unimportant, far from it; but because there is little new. Most of the recent progress in the diagnosis of ulcer has been made by improving the methods of physical examination.

The most striking symptom, of course, is hyperacidity or "hunger-pain," which is present in more than four-fifths of the ulcers. The frequency of hyperacidity has tempted so great a surgeon as Moynihan to say that "hyperacidity is ulcer." This, of course, is not true, yet he did us a great service. In severe chronic "hunger-pain" we no longer make the diagnosis of simple hyperacidity and let the matter rest there; we look farther in every case to see if we can find an organic basis for this symptom, and in the severe persistent cases we usually do find an organic basis. This is a chronic ulcer in about two-thirds of the cases of severe hyperacidity and either a chronic appendix or a chronic gall-bladder in the other third.

The patients usually have the soda habit, and many vomit. The symptoms are usually intermittent, and show a special tendency to occur in the spring and fall.

In addition to proving the *presence* of a chronic ulcer, it is very important to know its *position*, whether in the stomach or duodenum, for we know that duodenal ulcers rarely become malignant, while gastric ulcers quite frequently do. If the ulcer is in the stomach we also wish to know whether it is near the pylorus or well up on the lesser curvature, for the first is much more likely to cause obstruction than the second.

It is a waste of time to try to locate the ulcer by the symptoms alone, and the reason is obvious. If we watch the stomach with the fluorsocope we find that the pylorus usually opens within a few minutes and food is discharged into the duodenum. In other words, within a short time after food is taken, an ulcer, whether in the stomach or in the duodenum, is equally bathed in food, the irritation of acid occurs just as promptly in one as the other; both are equally stirred up by peristaltic movement and spasm. It

is far more satisfactory to look directly at the ulcer with the Roentgen ray and *see where it is*, than to trust to symptoms to locate it.

The *size* of the ulcer is also very important in ulcer of the stomach, on account of the frequency of cancer changes in the large ulcers. We cannot judge of this by the history alone; frequently the symptoms are very severe in a small ulcer and may be very slight in a large one. This is well illustrated by the two following cases:

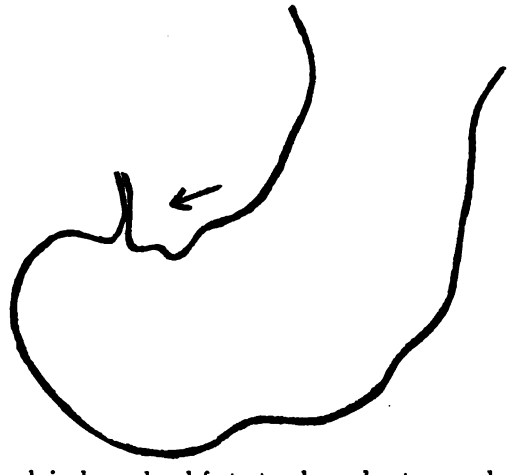


Fig. 135.—Good-sized annular defect at pylorus due to secondary spasm from small ulcer of posterior wall. (Case of Mrs. R. B.)

The first patient is Mrs. R. B., housewife, forty-five years of age. She has complained for two years of intermittent epigastric pain, with frequent vomiting, once of old food. The pain usually occurs one to three hours after meals. She has lost 20 pounds in weight. She has carious teeth, with pyorrhea. Abdominal examination shows finger-point tenderness 2 cm. below the xiphoid.

Test-meal showed normal secretion and a small twelve-hour residue. No blood in stomach contents or feces. *x*-Ray examination showed active peristalsis in the stomach, a good-sized residue up to twenty-four hours, with a moderate sized annular defect just above the pylorus (Fig. 135). Pain and vomiting improved but did not stop after ten days of medical treatment in

bed. The stomach emptied in eighteen hours under full doses of atropin. Operation was advised.

At operation a small ulcer with a crater 1 cm. in diameter was found on the posterior wall of the stomach about 4 cm. above the pylorus.

The following points are of special interest in this case: The symptoms were very severe and prolonged and yet the ulcer was scarcely more than 2 cm. in diameter. The ulcer was well above the pylorus and the long delay in emptying was due to spasm, not to organic obstruction. The large annular defect was due to secondary spasm from the ulcer, not to the ulcer itself. Even full doses of atropin only relaxed this spasm to a slight

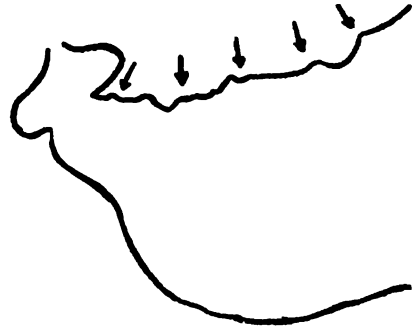


Fig. 136.—Long rigid irregularity of lesser curvature caused by large saddle ulcer. (Case of Mr. L. L.)

degree, and the improvement in emptying the stomach after atropin was only moderate.

This second patient, Mr. L. L., a Russian broom-maker, fifty-two years of age, complained of a slight cough for a few months. He had lost a little weight and had no digestive symptoms. A few days ago he "spit up" a little bright blood without nausea or cough. There was slight epigastric tenderness. *x*-Ray examination of the lungs showed increased density at both apices and a diagnosis of probable tuberculosis was made.

The stools showed a strong positive benzidin test for blood each time examined. This was the red flag of danger. We then made a systematic examination of the digestive tract and found that the

gastric secretion was very low, free HCl 5, total acidity 20. Blood was present. *x*-Ray examination showed a large six-hour residue and a rigid irregularity of the lower 10 cm. of the lesser curvature (Fig. 136). The diagnosis of large gastric ulcer with malignant changes was made.

In this case the digestive symptoms were so mild and unimportant that we almost made the mistake of not giving the digestive tract special study. Operation disclosed a large chronic, circular, saddle ulcer fully 12 cm. in diameter, with malignant changes.

With regard to *complications*, such as gross bleeding, the patient's history helps us. In order to count as a symptom the bleeding must be a real one, not merely a streak of blood, which is frequently found in any patient who has vomited repeatedly.

The presence of obstruction is often shown by the fact that symptoms which were intermittent become more or less continuous. The vomiting of old food is always important.

Acute perforation always gives us striking symptoms—pain, rigidity, collapse—while chronic perforation of ulcer, which, by the way, is twice as common as acute, gives no symptoms which can be distinguished from those of any chronic ulcer.

With regard to the development of cancer upon ulcer we must never wait for marked symptoms. We must get the text-book pictures of cancer entirely out of our head. If we wait for coffee-ground vomit, obstruction, lack of free HCl, palpable tumor, emaciation, etc., we have an absolutely hopeless case. In fact, I have heard that book of our great teacher, William Osler, on Abdominal Tumors called "a good autopsy manual" by a leading surgeon because it had so little clinical value.

The question is often raised whether cancer of the stomach is *ever* diagnosed early. A small cancer very rarely is unless it is just at the pylorus, as in Case 3.

In this third case a man of fifty years has had mild attacks of epigastric distress and vomiting for several years. General physical examination was practically negative. His gastric secretion was normal. No blood was found in stomach contents or feces.

There was, however, a small twelve-hour gastric residue, and *x*-ray examination showed a very small annular defect at the pylorus with slight irregularity (Fig. 137).

On account of the obstruction unrelieved by medical treatment and the possibility of cancer (which was emphasized by the radiologist) operation was advised. A small annular scirrhous cancer was found at the pylorus which was successfully resected.

In this case the cancer, while very small, gave early symptoms because it was at the pylorus and caused definite obstruction.

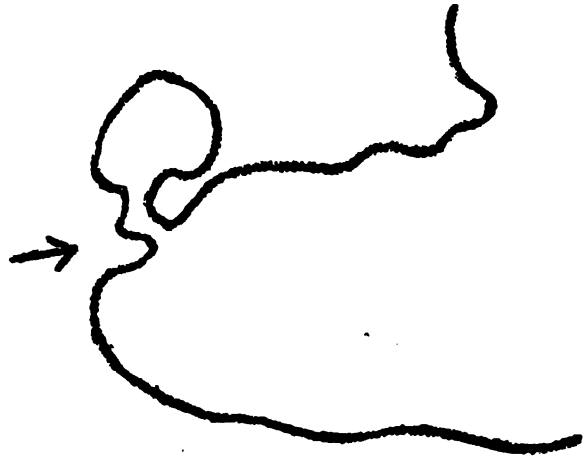


Fig. 137.—Small annular defect at pylorus due to small annular ulcer. Case 3 (from plate by Dr. A. W. George).

I want to emphasize, however, that *cancer on ulcer is and should be regularly diagnosed early*, not by the symptoms, but by the modern methods of examination which I will describe.

Physical Examination.—Since the valuable work of Rosenow and others we look much more carefully than ever before for sources of infection of an ulcer. We examine the teeth, tonsils, sinuses, appendix, and gall-bladder.

We note from statistics of operated cases that every third case of chronic ulcer has also an infected appendix and that every seventh case has an infected gall-bladder. If we examine the teeth carefully in ulcer cases we cannot fail to be impressed by the

large number of ulcer cases with infected roots. We must admit, however, that infected tooth roots are very common and great numbers of them are not associated with ulcer.

Modern diagnosis has shown that many of our older methods of examination were very imperfect. Let us briefly review some of these.

Take palpation—how little we feel in comparison with what we see with the Roentgen ray. In reviewing a large number of ulcer cases I find it is very rarely that I am able to palpate the ulcer. This is easily understood when we remember that the lesser curvature and the duodenum are the favorite sites with ulcer, and these are so frequently hidden under the edge of the ribs or liver that they are entirely out of reach when the patient lies on his back. Even tenderness is apt to be diffuse in the epigastrium, probably because we are not able to palpate very directly over the ulcer for the reason just given.

After having *seen* the ulcer with the Roentgen ray I have frequently returned to the patient in bed and absolutely failed to get any clear evidence of its presence by palpation.

Palpation of the erect patient before the fluorescent screen is another matter. If we see a deformed area and press directly over it, sharply localized tenderness has some value in diagnosing ulcer.

Percussion of the outline of the stomach is a method of very little value, which I have practically given up. If we percuss the stomach without inflating it the area of resonance is just about as likely to be the splenic flexure as the stomach, and if we percuss the stomach after moderate inflation with the patient on the back, we percuss the area of the gas-bubble which rises up under the abdominal wall in the middle of the stomach. In this position it gives us very little idea of actual outline. This is a very crude method and hardly worth the time it takes.

The *test of capacity* of the stomach, by pouring in liquid until the patient cries enough, is also of little value. The capacity of the stomach depends entirely upon the tone of its muscles. The normal stomach embraces its contents closely, no matter how small they are, and the amount which can be poured in without

discomfort depends almost entirely upon tone and sensitiveness, and varies greatly in different people with stomachs of the same size.

The *use of the stomach-tube* to test the secretion and emptying of the stomach has received a great set back since the free use of the Roentgen ray. I frequently see patients suspected of ulcer who have never been carefully examined except by the radiologist.

This is a mistake. There is no reason to give up the stomach-tube because we have the Roentgen ray. Tube tests are simple and cheap and give us valuable information. They are the only means of testing gastric secretion, and if secretion is either high or low we want to know it. They also tell us whether or not the stomach empties properly and about bleeding.

Tube tests have now taken their proper place, formerly considered very important, now always useful, but secondary.

The new Rehfuss tube, which is very small, like the Einhorn duodenal tube, is left in the stomach for several hours for the purpose of removing some of its contents for examination at intervals of fifteen or twenty minutes. The tube is so small that it is very easy to retain, and it has proved of very great value in studying the gastric physiology, but it cannot be considered a necessary diagnostic method in ulcer, and the frequently repeated examinations are not convenient outside a hospital or the office of a specialist.

Either the stomach-tube or the Roentgen ray can be used in deciding about the emptying time of the stomach. Twelve-hour residues are always important, and considerable six-hour residues call attention to the gastric function and require explanation. If we use the six-hour barium examination as a test of function we must allow no food in the interval. The radiologist is usually more interested in finding an actual lesion than in studying function, and is sometimes careless about the latter. I have seen several cases of ulcer in the last six months in which a report of good-sized six-hour residue was made and found that the patient took his barium meal at 10 A. M., took a hearty lunch at 1 P. M., and went for the six-hour examination at 4 P. M. The lunch held back some barium in the stomach and gave us a fictitious "six-

hour residue." This residue is a *minor* sign in ulcer, but as a test of function and guide to treatment it is valuable and should be carefully arranged. Fully two-thirds of the cases of chronic ulcer, whether of the stomach or duodenum, show some delay in emptying the stomach.

It is very important to decide whether this delay in emptying is due merely to spasm of the pylorus or to actual tissue narrowing. I want to emphasize here the use of atropin in deciding this question. Many a case of obstruction, which we believe at first to be organic, relaxes almost entirely under the use of atropin, and is shown to be merely the result of spasm. Dr. W. H. Mayo stated some years ago that delay in emptying the stomach in chronic ulcer is due to *actual tissue narrowing in less than 10 per cent. of the cases.*

This classification of the kind of obstruction is very important from the point of view of treatment. The cases with spastic delay frequently yield to medical treatment and are suitable medical cases. The cases with organic obstruction rarely yield to medical treatment and usually should go at once to the surgeon.

With regard to the use of atropin, we must not lay too much stress upon its use, for we find that full doses of atropin, even when continued for several days, do not always relax the spasm of an irritable stomach. The milder cases yield, the severer ones may not. In short, if a stomach relaxes and empties after the use of atropin we can conclude that the obstruction was due to spasm. If the obstruction does not relax after the use of atropin we have not absolutely ruled out spasm as a cause of delay. This point is well illustrated by Case 1 and also by this fourth patient. You note that I use only operated cases to prove my points, so we may be sure of our facts.

This fourth patient, Mrs. D. B., a woman of forty-six, has had indigestion for twenty-six years. Her husband had syphilis, and of her three children one was stillborn and two died within a few days. Her Wassermann reaction is negative.

She has complained of epigastric pain and vomiting about one hour after meals. This is always worse for ten days before and during the catamenia. In the last year she has been worse and

has lost 25 pounds. In the last two months vomiting has been persistent, with old food several times; no blood seen.

Test-meals showed normal secretion, blood present. *x*-Ray examination showed a deep incisura dividing the stomach into two equal parts (Fig. 138). The upper pouch emptied within five hours, the lower pouch was still full after twenty-four hours. The crater of a small ulcer was suggested in the lower pouch on the lesser curvature about halfway between the incisura and the pylorus. The pylorus was clear, smooth, and absolutely normal. With full doses of atropin the incisura did not relax and the lower pouch did not empty in twenty-four hours.

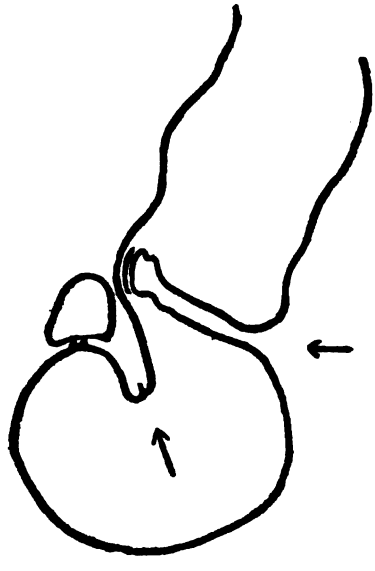


Fig. 138.—Hour-glass deformity from old healed ulcer, with small ulcer with slit-like crater lower down on lesser curvature. (Case of Mrs. D. B.)

We could not decide whether the hour-glass contraction was organic or spastic. We decided that the pylorus was normal, but was kept shut even for as long as twenty-four hours by severe reflex spasm from the small ulcer in the lower pouch.

Operation was advised and a true hour-glass stomach was found resulting from scar tissue and adhesions of an old ulcer in the middle of the lesser curvature. An ulcer 3 cm. in diameter was found halfway between the hour-glass contraction and the pylorus, the latter was normal.

The upper and lower pouches were connected by a wide gastrogastrostomy, the ulcer in the lower pouch destroyed with the cautery, and a gastro-enterostomy done. The patient made a perfect recovery and now is practically free from symptoms.

This case shows how difficult it may be to decide whether an hour-glass contraction is organic or spastic, and also how long a

normal pylorus can be kept closed by spasm from an ulcer some distance above it, and also how difficult it is sometimes to relax the spasm with atropin.

It is an interesting example of the intimate knowledge we can now get of all parts of the stomach and their workings by the combination of functional tests and the study of the living anatomy and physiology with the Roentgen ray.

Another important point—muscular spasm is a very variable, intermittent affair, and a patient with spasm of the pylorus does not always behave alike at different times, entirely apart from the use of drugs, and in deciding questions about treatment or operation on such a case more than one examination may be needed.

This fifth case, Mr. M. L., a clerk of twenty-four, suffered with hyperacidity for eight years, and nine months ago had several hemorrhages from the stomach, and after two weeks of medical treatment, in which bleeding continued, a gastro-enterostomy was done. His diet since operation has been careless at times and intermittent hyperacidity continued with rare vomiting. He gained 30 pounds since operation.

A week ago an *x*-ray examination, at another hospital, showed active peristalsis, the greater part of the food passed through the pylorus and only a little through the new opening. There was a medium-sized six-hour residue. Because of the persistent symptoms—hyperperistalsis, gastric stasis, and small passage of food through the stoma—a diagnosis was made of partial closure of the new opening and a second operation advised. The patient objected to this and came to us for examination.

On two separate occasions the stomach emptied rapidly, leaving no residue in five or six hours. We saw no ground for operation and the patient has been entirely free from symptoms for months with more careful diet and medical treatment. We can only explain the difference in the action of the stomach on the several occasions by the variable amount of pyloric spasm. It is not always safe to make an important decision after a single examination of the stomach.

The effect of ulcer deformity on the emptying of the stomach is a very interesting question. We find with the Roentgen ray

that the oldest ulcers, as a rule, show the most deformity, but they do not necessarily show the most obstruction. Deformity means old scar tissue or adhesions as well as active ulcer which may cause much deformity from spasm. Case 1 (Fig. 135) is a good example of a small ulcer with much obstruction and Fig. 139 shows a duodenal ulcer with a great deal of deformity but no obstruction at all.

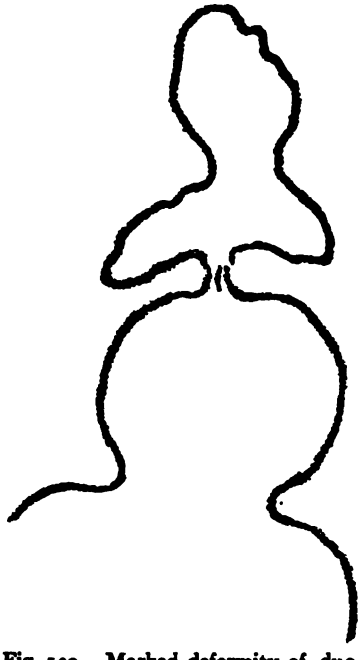


Fig. 139.—Marked deformity of duodenal cap with no obstruction.

Tests for blood we will pass over briefly, as they are well known. A test for blood in the feces on a meat-free diet in the absence of piles is a red flag and shows something is wrong. Blood in the stomach contents with delicate tests, such as guaiac or benzidin, is much less important, as it comes frequently from the slight rubbing of the tube. Personally I much prefer the benzidin to the guaiac test on account of its somewhat greater delicacy and easier technic. I will give the best technic of the old benzidin test. I see it so variously done and its delicacy depends so much on technic.[1] One of the best ways of testing

[1] The material for examination consists of simple gastric contents; or of a pea-sized piece of feces thoroughly stirred in a test-tube into about 4 c.c. of water. This is brought to a boil to destroy oxidizing ferments. Ten drops of a fresh solution of benzidin (prepared by shaking a knife-tip of benzidin in about 2 c.c. of glacial acetic acid) is added to 3 c.c. of a 3 per cent. (ordinary commercial solution) of hydrogen peroxid in a test-tube. This mixture serves as a control of the cleanliness of reagents and glassware.

To make the test, add 2 or 3 drops of the boiled gastric contents or of the feces mixture to the peroxid-benzidin mixture without shaking. A clean green or blue ring appears within a minute or two when blood is present.

It is best to use only pure reagent of best quality and to avoid peroxid solutions containing acetanilid as a preservative. I use dioxygen. The glassware must be scrupulously clean.

feces is to smear a thin layer on a clean slide with a glass rod or match and pour a few drops of the benzidin-peroxid mixture on it.

The simplest blood test for the practitioner are the ***benzidin tablets*** of Dudley Roberts, put up by Squibb & Sons. One tablet is placed in a clean saucer with enough stomach contents to wet the tablet thoroughly, but not to cover it. Then a drop or two of glacial acetic acid is dropped upon the tablet; if blood is present the tablet turns greenish blue. The same test can be used with feces, thinned with a little water.

Blood tests should not be relied on to *diagnose* ulcer, since we only get a positive result in about one-third of the cases. They do help us to judge the activity of an ulcer and also to rule out cancer. The latter is far more likely to give a positive test and give it constantly.

The *Einhorn string test* I consider a thing of the past. It has little value. I have given it a thorough trial and have given up using it. The results are difficult to interpret. Smithies found it positive in only 7 cases out of 318 gastric ulcers which were verified by operation.

We do a *Wassermann reaction* as a routine on ulcer cases. The results show that syphilis is a rare cause or associate of ulcer. A positive reaction was found in less than ½ of 1 per cent. of a series of about 200 private cases of ulcer and in less than 2 per cent. of about 200 hospital cases of ulcer. This figure is distinctly less than the percentage of syphilis in total hospital cases, which is at least 4 or 5.

The **Roentgen ray** is our newest and greatest addition to the methods of diagnosing ulcer, and it sometimes seems as if it were worth more than all the other methods put together, but this is hardly true; as a matter of fact, and if patients are carefully studied the diagnosis is made in four-fifths of the cases of chronic ulcer before the *x*-ray examination is begun.

The Roentgen ray, however, does help us immensely, not only in deciding whether an ulcer is present or absent but also where the ulcer is, and how large it is. These questions are very important, as I have already said. The Roentgen ray also helps

greatly in diagnosing doubtful gall-bladder and appendix cases which simulate ulcer.

With the discovery of the great value of Roentgen examination in ulcer a bad practice is growing of sending poorly studied digestive cases to the radiologist and accepting his word as final. Let me warn you against an "*x*-ray diagnosis" of any gastro-intestinal lesion.

Twenty-five years ago at Harvard I was taught to make a complete genito-urinary diagnosis from a bottle of urine. We do not do that any more. We want the patient, his history, his other physical signs, as well as the urine to give us our diagnosis. A sputum loaded with tubercle bacilli may be enough to settle a case, just as the deep ulcer crater in the lesser curvature with deep incisura or the constant marked clover-leaf deformity of the duodenum usually is distinctive of ulcer; still we do well to take the Roentgen examination as Roentgen evidence and put it with the other clinical evidence in making a diagnosis. I have seen dreadful mistakes made from one end of the gastro-intestinal tract to the other from disregard of this rule. I have seen cancer of the esophagus diagnosed by a leading radiologist when a second year medical student could have made the correct diagnosis of cardiospasm from the history of *dysphagia of ten years' duration without loss of weight* in a very nervous man. I have seen a diagnosis made by an expert of a gall-bladder packed full of stones, when at operation (incidentally fatal) no disease of the gall-bladder was found. I have seen a report of an entirely normal colon made by another leading radiologist in a man constantly passing pus and blood, and a second examination reveal a cancer of the sigmoid previously hidden by a loop of bowel.

We want Roentgen evidence, not a Roentgen diagnosis. Not all Roentgen evidence is alike; some is very slight and dubious, some very strong, like, for example, the difference between palpating a large irregular abdominal tumor in a thin patient and feeling a vague resistance in a fat one. The profession is not yet educated to recognize these differences in Roentgen evidence. We must remember that the radiologist, like every other consultant, often faces a disagreeable dilemma. He naturally wishes to

make his diagnosis as definite as possible, but the evidence is often doubtful.

This is not the place to discuss the technical details of Roentgen-ray examinations. I will merely say that in chronic ulcer the tendency is to base our diagnosis less on so-called indirect signs, such as changes in peristalsis, spasm, and six-hour residue, and lay most stress on the actual demonstration of the ulcer itself by finding a defect in the stomach or duodenal wall. The indirect signs are valuable. They serve as a red flag and call our attention to the fact that something is wrong with the stomach which requires explanation, but they appear in ulcer *and in other conditions also* which cause reflex irritation and spasm of the stomach, such as chronic appendix or gall-bladder or a general condition of nervous irritability.

There is probably not a place in the digestive tract where Roentgen signs are so definite as in the duodenum; not in the stomach or in any other part of the bowel. This is because the lesions are found in the first inch or so of the duodenum, and we can concentrate our attention on a very small area. Where the best technic is used, definite evidence of duodenal ulcer is found in 90 per cent. or more of the severe chronic cases which come to operation. In the milder cases this percentage is not so high, and we have some difficulty in distinguishing ulcer from adhesions.

The chronic indurated ulcer of the stomach along the lesser curvature or near the pylorus is usually found with ease with the Roentgen ray. This is very important. *This is our opportunity to prevent cancer* by discovering the *location* and *size* of the ulcer. Size is very important, for MacCarty has shown that more than half of the ulcers of the stomach, with a crater as large as a quarter, are becoming malignant. We very rarely discover an early *primary* cancer, but we can discover and locate the good-sized gastric ulcers and get them to the surgeon in time to prevent the spread of hopeless cancer.

Let me explain this so there may be no mistake. We cannot look at an ulcer with the Roentgen ray and tell by its *anatomy alone* whether it is cancerous or not. These microscopic changes in the cells of the ulcer do not show on *x*-ray plates. If any one

has any lingering doubts on the matter let him read MacCarty's paper on "The Pathological Reasons for the Legitimate Error in *x*-Ray Diagnosis of Gastric Carcinoma and Ulcer."[1]

The important point is not anatomy, but *location* and *size*.

It is said that the soft, freshly bleeding ulcer is often missed on *x*-ray examination, and also that ulcers of the posterior wall may be easily overlooked because we cannot get them in profile. They are hidden behind the mass of material in the stomach in front of them.

I do not know what to say about the soft, freshly bleeding ulcer, because Roentgen examinations are usually not made in such cases at the active stage, but with regard to ulcers of the posterior wall I do not think they are very often overlooked. By examining the stomach in various oblique positions we get almost every side of the stomach in profile, and, in addition, an ulcer of the stomach, wherever placed, usually causes irritation and spasm of the circular fibers of the stomach, and we have a telltale spasm or incisura just at the level of the ulcer. Case 1 is an example of this. There was a very large circular spasm near the pylorus, and instead of finding a large ulcer at operation, as might be expected, we found a very small ulcer of the posterior wall. In addition, if we watch the stomach fill, with ulcer of the posterior wall, the filling is often irregular, a little puddle of barium collects near the ulcer, which later is covered up. Pyloric spasm and delay in emptying is naturally just as common with posterior ulcers as with any others, and by a combination of all these signs they are usually found. It is harder to judge their size than those of the lesser curvature and it is harder to follow the results of treatment by looking at them.

Statistics about the frequency with which chronic ulcer is found have not much value. They apply only to the more severe cases, with marked deformity, which are readily found, and which are much more likely to come to operation than the doubtful ones. There is no question that the Roentgen-ray examination almost always detects marked cases of chronic ulcer, "the surgical clinic cases," and, as a matter of fact, does a good deal more than

[1] American Journal of Roentgenology, February, 1917.

this. We can distinguish quite a variety of anatomic and functional types of ulcer with the Roentgen ray. The ulcer may be high or low, small, bitten out, or large and rigid, or deeply perforating, or with hour-glass deformity, or obstructive. We may have several types of peristalsis or spasm or incisura.

Several of these are illustrated by Figs. 142 to 146. A few tracings of the normal duodenum are shown for comparison (Figs. 140 and 141).

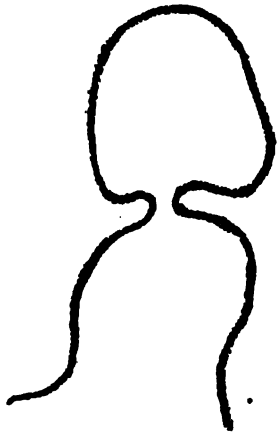


Fig. 140.—Normal duodenal cap (life size).

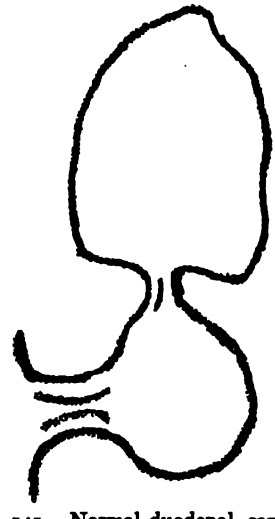


Fig. 141.—Normal duodenal cap (life size).

The Roentgen ray can also be used to great advantage, as I shall show at another time, in judging the results of either medical or surgical treatment, by detecting the anatomic changes which have occurred in the course of healing and in showing the changes which have occurred in peristalsis and in the emptying of the stomach. These changes in motor function can, of course, be readily detected by the use of the stomach-tube after an appropriate meal, and this method, so simple and easily applied, should be freely used for this purpose by the general practitioner. On the other hand, a single glance with the fluoroscope five or six hours after a barium meal gives us similar information without the necessity of troubling the patient or the stomach with

the tube, and is very convenient where the Roentgen ray is available.

This *late diagnosis* of the condition of ulcer after treatment I consider very important, so much so that I repeat some of the functional tests after two or three weeks of treatment, and also ask all cases to report for examination at least once in three months for the first year after treatment whether symptoms are present or not. I make a general physical examination, test the stools for blood, estimate the motility of the stomach with a barium meal, and make a direct examination of the ulcer with the Roentgen ray, using the fluoroscope or plates.

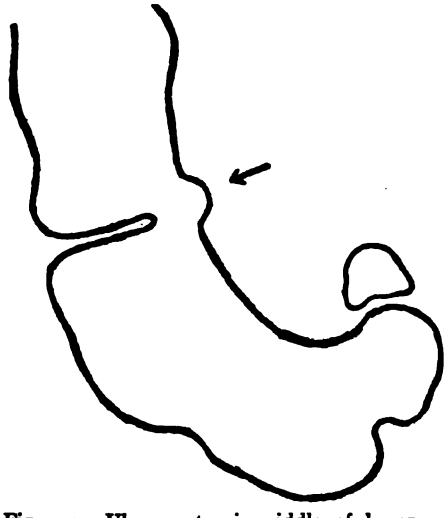


Fig. 142.—Ulcer crater in middle of lesser curvature with incisura opposite.

Fig. 143.—Deformity of cap due to duodenal ulcer (life size).

This kind of examination helps us, above all, to *individualize the treatment.* All ulcer cases can no more take the same treatment than all diabetics can eat the same diet. We treat ulcer according to its position and size and the changes in function which go with it. The treatment is an experiment to be watched and followed, like increasing the diet in a diabetic.

I want especially to emphasize the *need of a good follow-up system* in chronic ulcer. This is just as necessary as in diabetes. These ulcers are essentially chronic. This should be carefully

explained to the patient. The greatest failure I see in medical treatment is the lack of following the cases carefully for months and protecting the stomach from irritation for a long time.

There is no such thing as "the ulcer treatment" any more than "the diabetic diet." We do not want to lose track of a case of diabetes and only have him report when there is sugar in the urine, neither do we wish to lose track of a chronic ulcer and only have him report when his symptoms recur. To watch the patient with chronic ulcer and protect him from recurrence is just as much our business as to keep the diabetic sugar free.

Fig. 144.—Deformity of cap due to duodenal ulcer (life size).

Fig. 145.—Deformity of cap due to duodenal ulcer (life size).

Fig. 146.—Deformity of cap due to duodenal ulcer (life size).

This observation of the patient has great value in protecting him from cancer. It is safe to say that in nine-tenths of the ulcers which "go bad," cancer could be avoided by an efficient follow-up system and constant weeding out of cases unsuitable for medical treatment.

It is interesting to note that while we have seen the deformity of *gastric* ulcer entirely disappear in a number of cases after medical treatment, thus far we have not seen a single markedly deformed duodenal cap which has filled out to its former smooth plump contour after treatment. This is true even in cases which have remained entirely without symptoms for a year or more and which we consider cured. The deformity of the duodenum has greatly lessened, but *not entirely disappeared.* Evidently a

certain amount of scar tissue or adhesions have persisted which still deform the delicate wall of the duodenum.

The things which I especially wish to emphasize in this clinic are as follows:

Some of our older methods of examination of the stomach in ulcer, such as palpation, percussion of outlines, and string tests, are very imperfect. We must not rely on them, but use better ones.

The stomach-tube should not be given up simply because we have the Roentgen ray; use both, they supplement each other.

Tests for blood have more value in showing the activity of an ulcer and in ruling out cancer than in diagnosis of ulcer.

A pure "Roentgen diagnosis" of ulcer or any other gastro-intestinal lesion is undesirable. Examine the *patient* as well as the plates. Roentgen evidence is not all alike, some is strong, some is weak.

Value of the Roentgen examination in chronic ulcer, not only to detect the ulcer, but to locate it and measure its size.

The importance of knowing where the ulcer is and how large it is in making an *early* diagnosis of cancer developing on ulcer, and thus protecting the patient.

Obstruction of the pylorus is usually due to secondary spasm from ulcer, not to actual obstruction by ulcer tissue or adhesions.

The use of atropin in deciding which stomachs with ulcer can be made to empty and which cannot. The classification of the kind and degree of obstruction is very important in choosing medical or surgical treatment.

The variability of spasm of the pylorus, and the necessity of more than one examination of the stomach in deciding important questions about gastric motility and its treatment.

The aid of the Roentgen ray in making a *late diagnosis* of the condition of ulcer during and at intervals after treatment, by direct observation of the anatomic and functional changes, which take place in the stomach and in the ulcer. A good follow-up system is just as necessary in chronic ulcer as in diabetes.

The deformity in gastric ulcer often disappears entirely after treatment. In duodenal ulcer this is evidently much less common.

CLINIC OF DR. K. H. THOMA

ROBERT BRECK BRIGHAM HOSPITAL

THE RELATION OF THE TEETH AND JAWS TO GENERAL MEDICINE

The Interrelation of Oral Infections and Somatic Diseases. The Effects of Infection. Bacteria and Bacterial Poisons. Frequency and Pathology of Oral Infections. Subperiosteal and Subgingival Abscesses. Dental Granulomata. Cysts. Pus Pockets and Pyorrhœa Alveolaris. The Mode of Distribution of the Infection in Oral Focal Disease. The Importance of Always Investigating the Mouth.

SUPPURATIVE processes of the jaws due to diseases of the teeth have occurred in all periods of history. The Greek historian Herodotus, who went to the shores of the Nile to learn the sacred mysteries and sciences of the Egyptians, found that surgery and medicine were divided into distinct professions and that among these specialists there were surgico-physicians who treated the diseases of the teeth. Tooth abscess must have been a very common trouble in the Predynastic Egyptian period as well as in the Old and Middle Empires, and apparently it was not known at that time that the extraction of the tooth would have speedily cured the trouble. I was fortunate in being able to examine a group of ancient Egyptian crania of those periods at the Peabody Museum of Harvard University, which date back to the year 4800 B. C. Among them I found a large number showing destruction of bone due to alveolar abscesses which was extensive in many cases.[1] If we continue our studies of anthropology we find in the writings of Hippocrates, who was born 460 B. C., the

first observation of systemic effects due to dental disease. He says that at the approach of dentition pruritus of the gums ("gingivarum exulcerationes") occurs, and fever, convulsions, and diarrhea, especially when cutting the canine teeth. The period of dentition was apparently accompanied by a great deal of trouble in those times and was probably frequently complicated by infection. In our more recent literature we find many cases of septicemia and pyemia originating from mandibular or maxillary infection, and no one today will dispute the fact that in the oral cavity you may have conditions present from which acute general infection can result. The discovery that an infectious focus may be the source of entirely different conditions than those observed in acute general sepsis has only recently been recognized. Careful clinical observation, extensive research work, and animal experiments have shown that a large number of local and general diseases are due to an infectious focus in some remote part of the body. This, in turn, has opened up a new field to researchers in oral surgery and has revolutionized diagnosis and treatment of dental and oral diseases.

I shall not endeavor to discuss the theory of focal infections. It may, however, not be amiss to say that the focus must not necessarily be in an acute condition; it is rather more frequently a chronic lesion which is quite often disregarded by the patient and physician because it may not give any local discomfort, and unless it is on the surface its site can only be located after the most careful examination by well-trained specialists.

The Site of the Focus.—The most frequent location of the focus of infection is in the head, and especially in the nose and accessory sinuses, the throat, the mastoid process, and the oral cavity. The gastro-intestinal tract with the vermiform appendix and the gall-bladder, as well as the genito-urinary tract, are other fields in which we often find primary lesions which cause systemic disease. It is not in the scope of this paper to describe all the diseased conditions which lead to secondary involvement of other parts of the body, and I shall, therefore, confine myself to the diseases of the mouth and teeth, their relation to local and general diseases and their clinical manifestations.

The Interrelation of Oral Infections and Somatic Diseases.—Dentists have discovered long ago that during the developmental stage of the teeth general diseases may produce lesions in the tooth germs. Scarlet fever, measles, and congenital syphilis may be the cause of permanent defects of the enamel, easily recognizable in the erupted teeth. In tuberculosis, typhoid fever, and syphilis we frequently find secondary lesions in the mouth. That the reverse condition is possible is a logical conclusion. It has been borne out further by observation of cause and effect, by animal

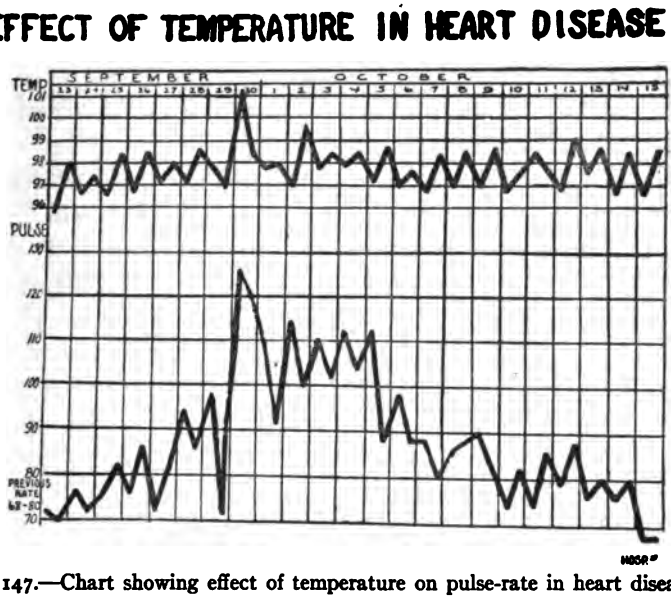


Fig. 147.—Chart showing effect of temperature on pulse-rate in heart disease.

experimentation such as undertaken by Hartzell and Henrici,[2] by bacterial studies in finding the same bacterium in the focus and secondary lesion, and still further by carefully following up the effect upon the general health and secondary lesion from eliminating the focus. In connection with this we must bear in mind that we may get an improvement as an indirect result by improving the general health of the patient.

Effect of Infection.—Through the courtesy of Dr. McCrudden, of the Robert Breck Brigham Hospital, I take pleasure in re-

producing some of the charts he has made in connection with his studies of infections.

The *first chart* (Fig. 147) shows the effect of temperature in heart disease. The patient, Hospital case No. 239, had a past history of measles and scarlet fever when a child, had first signs of heart trouble eight years ago, used to get somewhat short of breath, but has been fairly well up to three years ago; has recently had attacks of heart trouble with dyspnea and slight swell-

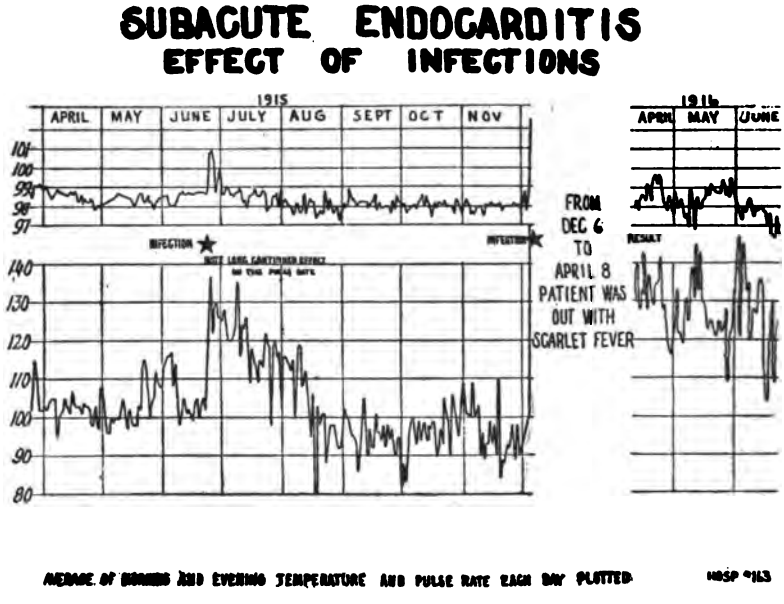


Fig. 148.—Chart showing the long-continued effect of an infection on the pulse-rate.

ing of feet and ankles. Diagnosis was made of aortic regurgitation and double mitral. September 30th a slight infection occurred which is indicated by a rise of temperature to 101.4° F. and to 99.8° F. on October 2d. The effect this had on the heart is indicated by the pulse-rate which remained between 90 and 125 for several days.

The *second chart* (Fig. 148) shows the effect of an infection in a case of endocarditis. The patient, Hospital case No. 163, a child three years old, had the following past history: Began to

walk at one year of age, German measles and pertussis at one year, sore throats at different times and fever, but cannot remember just when. Examination reveals a systolic murmur heard in mitral area, in axilla, and left back, presystolic roll and thrill at apex, diastolic murmur heard over aortic area and transmitted downward. She was admitted to hospital March 25th; temperature was below 99° F., and pulse between 100 and 110 until June 24th, when an infection occurred which is indicated in the temperature curve by a rise for a few days (note the long-continued effect on the pulse-rate which lasted until August 15th). A very serious infection occurred in December when the patient contracted scarlet fever and was away from the hospital from December 6th to April 10th. The serious and long-continued effect this had on the heart is shown on the right-hand side of the chart. Note that the pulse-rate remained between 120 and 145 for three months more, up to June 22d, when she died.

The *third chart* (Fig. 149) I compiled from two of Dr. McCrudden's charts. It shows the effect of a vaccine on the strong heart (of Hospital case No. 225) and on the weak heart (Hospital case No. 211). The former was a patient fifty years old, suffering from chronic arthritis, and had the following past history: Had measles and scarlet fever when six years old. Her present illness started a year ago last May (twenty-one months ago), when she began to notice a pain in the ball of the left foot. Soon after this the ankle and the shoulders became lame and painful. The foot was swollen at the time, but more particularly at night. The wrist and knees next became involved. In December she was obliged to give up work altogether and has been bed-ridden ever since. She was a well-developed and well-nourished woman, lungs normal, heart sounds regular and of good quality, no thrills were palpable, no cyanosis or edema. Otherwise normal except for the loss of function in the shoulders and deformity of the left wrist. She was admitted February 3d. February 20th vaccine treatment was begun. Injection made at 3.30 P. M. into median basilic vein of right arm of 75,000,000 typhoid bacteria with 100 c.c. of normal salt solution. She had a definite chill which lasted twenty minutes, but otherwise no heart symptoms. Temperature

and pulse curve show on chart, and by 9.30 P. M. these were normal. Patient said she had the most restful night she had had for a long time. February 28th vaccine, 100,000,000 bacteria, injected into right arm at 4 P. M. At 4.45 P. M. a severe chill occurred, lasting about twenty minutes. Temperature curve as shown on chart was normal again at 9.45 P. M.

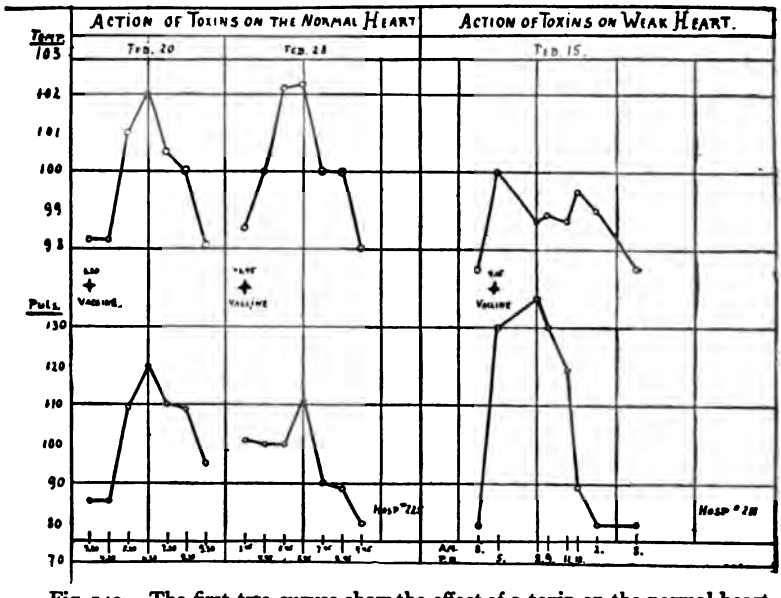


Fig. 149.—The first two curves show the effect of a toxin on the normal heart. Note the effect on the pulse. There were no heart symptoms. The third curve shows the action of the same toxin on a weak heart. Note the pulse curve. From 5 P. M. until the next day there were marked cardiac symptoms, dypsnea, cyanosis, coughing, headache, salmon-colored sputum, and tenderness over precordia .

The second patient, Hospital case No. 211, a woman thirty-six years old, was admitted for chronic arthritis. The following is her past history: Measles and diphtheria and scarlet fever when a child. At age of twelve years had "Saint Vitus dance" which lasted two years. Had two attacks of pneumonia when fifteen years of age; rheumatic fever seven years ago, short attack, one month, febrile, all joints, no after-effects in joints, no subsequent acute attack, no tonsillitis. Present illness began eighteen months ago, when she noticed pain and stiffness of the

left knee which was soon followed by an involvement of the right knee. A year later the left elbow began to trouble her, followed by similar involvement of the right elbow. Six months ago was troubled with pain and swelling in the joints and fingers of both hands. Appetite good; no digestive discomfort; no coughing or expectorating; no dyspnea, does not complain of shortness of breath or palpitation; has had some edema in ankles; no headache. The following is the report of the examination: Present examination: recumbent, slight edema of both ankles, teeth poor, glandular enlargement in submaxillary region on both sides; heart—apex-beat not visible, apex-impulse felt in fifth interspace, midclavicular line, base on level with third rib, apex in fifth interspace, right border 3½ cm. from midsternal line; left border 11 cm. from midsternal line, P_2 greater than A_1.

While there was no evidence of physiologic heart disease, a systolic murmur was found. When admitted October 9th she complained of pain in joints, trouble with right hip and elbows, but generally was in good condition. February 15th vaccine administered, 75,000,000 bacteria intravenously at 4.15 P. M. At 5 P. M. patient showed signs of reaction—chill, typical spasmodic shaking, but no complaint of cold; had marked cardiac symptoms at 9 P. M., patient was dyspneic and cyanotic and coughing. Sputum was salmon colored. Distress, dyspnea, and headache lasted until about midnight. Next day there was tenderness and palpitation over the precordia.

These 2 cases therefore illustrate that a patient with a strong heart can take care of a slight infection such as a vaccine, while the other patient, who had no physiologic heart disease but whose heart was weak, developed from a small infection such as the administration of the same vaccine most severe heart distress.

The *fourth chart* (Fig. 150) shows the improvement which resulted in a case of endocarditis through the removal of two teeth with chronic abscesses. The patient, Hospital case No. 116, age thirteen, had measles when very young and scarlet fever seven years ago. He had never had any sore throat. Seven years ago he started to have pain in the joints, mostly in the shoulder region, associated with fever. Shortly afterward he

complained of pain over the precordia and of dyspnea upon exertion. He was kept in bed except for meals. Physical examination showed lungs negative, heart-apex visible and palpable in fifth interspace, 11 cm. from the midsterum. Over the apex was felt a distinct presystolic thrill; sounds were of fair quality, but rapid, at mitral area is heard a presystolic murmur; over aortic area is a diastolic murmur and over pulmonic area is a systolic murmur. Patient was admitted to the hospital November 6th; temperature 100.6° F., pulse 140, respirations 28, blood-

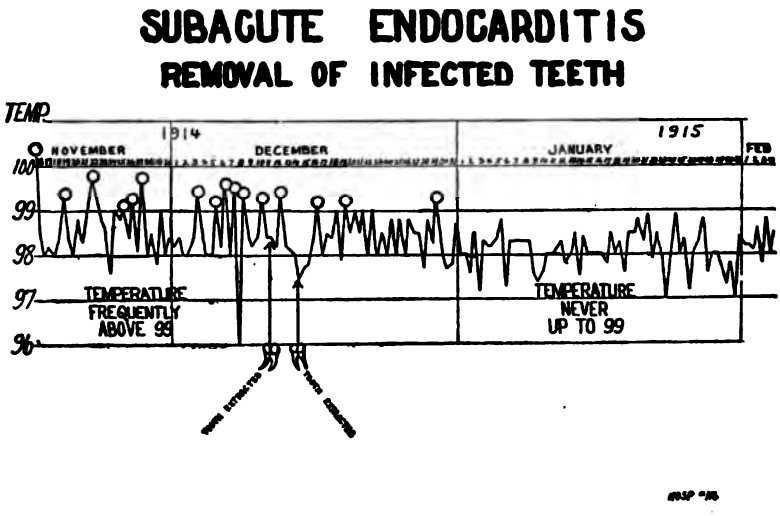


Fig. 150.—Chart showing the effect of the removal of infected teeth on the temperature curve in subacute endocarditis.

pressure $\frac{125}{80}$. He was put on a light diet and kept in bed. x-Rays taken of his teeth showed abscesses at the roots of two lower first molars. I extracted the first on December 11th and the other on December 14th, and after this the temperature was only three more times over 99° F. in December, and in January it was never up to 99° F. From the time he was admitted until the time he received dental treatment, December 11th, the temperature was quite frequently above 99° F., as indicated by the red circles.

The *fifth chart* (Fig. 151) shows, besides temperature and pulse, a weight curve indicating the effect of infection upon nutrition.

The patient, Hospital case No. 76, is a case of subacute endocarditis in a girl aged sixteen. She had measles and whooping-cough in childhood, rheumatic fever three times, the first time when a child, the second time one year ago, the third time in March or April. Two months ago operation for appendicitis; after discharge from hospital following operation was taken with German measles and rheumatism and was in hospital for three weeks. Left hospital on a Thursday, and on the following

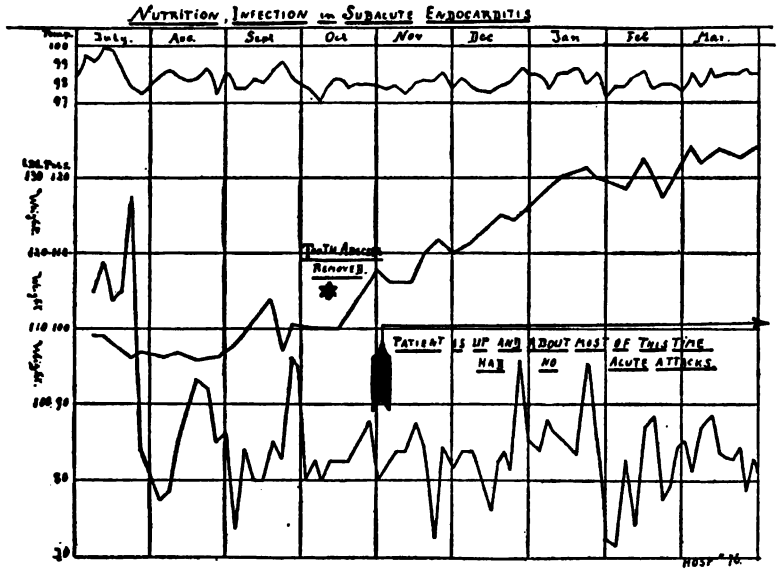


Fig. 151.—Chart showing temperature and pulse plotted over three days. Note the increase in weight, as demonstrated by the middle curve after the removal of a tooth abscess. The patient was up and about most of the time and had no acute attacks after the middle of October.

Tuesday felt weak and became unconscious. Following this came rheumatism, beginning in hands (joints), wrist, left shoulder, and neck; pain across upper part of chest. Examination shows a well-developed and fairly well-nourished girl, color pale, lungs normal, heart action rapid but regular, presystolic thrill palpable over the apex, loud blowing presystolic and systolic murmurs loudest over apex and transmitted outward; also diastolic murmur. Patient admitted July 5th, received

house diet for a short time at first, later milk, bread, and fruit. The treatment was principally quiet, rest, full diet, and digitalis. She had complained of a "sinking feeling" quite frequently at first, but later only occasionally. October 12th had left bicuspid extracted, x-ray of which showed abscessed root. After this she improved noticeably, and since November has been up and about most of the time without acute attacks. Her weight has increased from 110 to about 130 pounds in the last few months, as shown in the curve of the chart.

Bacteria and Bacterial Poisons.—The mouth is an ideal place for bacterial life, and an unclean mouth or one containing diseased conditions may harbor any number and variety of fungi, yeast, pathogenic and saprophytic bacteria. The most infectious lesions of the mouth may be caused by any of a large number of pyogenic bacteria, and secondary invasions of saprophytes is rather the rule than the exception. The latter live upon the products of decomposition and have a great deal to do with the formation of gases, the odor of the exudates, and the color of the pus. Originally the bacteria of the mouth were studied with the idea of finding one of them to be the etiologic factor of a definite lesion, but no one has been able to demonstrate specific organisms in the various diseased conditions. Any one of the pyogenic bacteria may cause an alveolar abscess or a pus pocket at the gingival margin. We almost always find a mixed infection with a great variety of combinations. The following list gives the bacteria which are most commonly found in oral lesions:

Streptococcus hemolyticus (often found in acute abscesses).
Streptococcus viridans (very common in blind abscesses).
Staphylococcus aureus.
Staphylococcus albus.
Diplococcus pneumoniæ.
Diplococcus of Connellan-King.
Bacillus typhosus.
Bacillus tuberculosis.
Bacillus mesentericus.
Bacillus tetragenus.
Bacillus pseudodiphtheriæ.

Bacillus fusiformis,
Bacillus bifidus communis,
Bacillus ramosus,
Bacillus perfringens,
} anaërobic.
Fungus actinomyces.

Many of these bacteria may reach, through certain channels which will be described later, various parts of the body where they will cause disease, but also the protein poisons formed in the focus by bacterial activity may become absorbed. These poisons or toxins are derived from the molecular disruption of the invading organisms setting free the intercellular toxins and by the bacterial metabolism; the by-products of the extra- and intracellular ferment action of both the pyogenic and saprophytic bacteria are almost always relatively strong poisons to the host. Various colored pigments are formed which have not been studied very much. From nitrogenized bodies or protein bodies, which constitute the greater proportion of animal tissue, there are formed complicated protein poisons, ammonia, ptomains, alkaloids, hydrogen sulphid, aromatics (indol, skatol, phenol, tyrosin), and gases such as nitrogen. From carbohydrates and animal fat there are formed acids (lactic acid, formic acid, acetic acid, butyric acid) and gases (carbon dioxid, nitrogen, methane, hydrogen). These by-products are usually easily recognized by the odor. Let him who doubts the danger of infected teeth and pus pockets be present at the dental operation and in close proximity to the foul, pus-soaked, discolored tooth, the ill-fitting crown or fixed bridge that is removed, and he will soon be convinced that such substances, if absorbed into the system, must be injurious to the health.

Frequency of Oral Infections.—Most of the infectious lesions of the mouth are of chronic character; quite frequently they are not noticed by the patient and have started and existed for a long period without local symptoms. As no special complaint is made by the patient, such diseases may develop under the very eyes of the dental practitioner, who, as a rule, spends little time in making a thorough examination of the mouth and adjacent parts, being too busy with his routine work and its many important and com-

plicated details. These chronic lesions are just the ones which are so frequently the cause of focal infections. To show the frequency of oral lesions Black[3] had roentgenograms of all the teeth of 300 patients taken. These examinations were not made because of any definite indication or dental complaint, and consequently represent as nearly average conditions as can be obtained. The following tabulation gives the results:

Age.	Number of patients.	Average number of teeth per person.	Percentage of persons having infections of the maxillary bones.
Under 25	86	30	56 per cent.
25–29	53	29	72 per cent.
30–39	68	26	87 per cent.
40–49	53	25	89 per cent.
50 and over	40	23	100 per cent.

To show the frequency of oral infections in patients at a hospital for chronic diseases let me cite the result of my first examination of the patients at the Robert Breck Brigham Hospital: I examined 81 patients; oral infections were present in 72 patients, or 90 per cent. Of the remaining 9, 2 had a mild pyorrhea, 6 needed fillings and restorations, and only 1 did not need any dental attention. I have extracted 334 teeth from the 72 patients on account of abscesses and severe pyorrhea.

Pathology of Oral Infections.—Acute alveolar abscesses are seldom neglected by the patient on account of the alarming symptoms which accompany the disease. The infection usually occurs at the end of a root and in such cases is transmitted from an infected dental pulp. The fibers of the peridental membrane, which have a wonderful resisting power, are infiltrated with pus which finally destroys the peridental tissues and spreads in the cancellous part of the bone. In this state we call it an acute alveolar abscess. The pus, having no outlet and being under pressure, involves the Haversian canals, which furnish a passage to the outside of the bone where the pus first collects under the periosteum. The periosteum is elevated from the bone and the patient experiences extreme pain. The temperature rises, the gum shows a swelling of red appearance, accompanied by a widely distributed edematous swelling of the face. This condi-

tion is called a subperiosteal abscess. When finally the periosteum is penetrated the symptoms become less marked; the pus collects under the gums and is called a subgingival abscess. The mucous membrane shows a light spot where the abscess points and where the pus will find an outlet to the mouth or face. The disease so far has been a process of destruction and if the condition is left to itself or after unsuccessful treatment the process of reparation begins. This attempt at healing consists in formation of granulation tissue, and the abscess is now called a chronic abscess.

Chronic Alveolar Abscess.—After the pus has found an outlet, the symptoms of the inflammation gradually disappear, the surrounding tissues having been rendered immune. Pus discharge from the sinus, however, continues just the same as long as the cause remains. The chronic inflammation may be kept up by the necrotic dental pulp which has only been partially removed or has not been removed at all, or it may be due to the condition of a root apex which forms an obnoxious foreign body if it becomes denuded from the peridental membrane, impregnated with pus or partly absorbed, as seen in Figs. 152–155. Therefore it frequently happens that the patient, who has no more discomfort believes the abscess entirely cured, while all the time it continues in a chronic stage, discharging pus from a sinus into the mouth, where it is mixed with saliva and disintegrates the food.

Acute Abscess Due to Difficult Eruption of Teeth.—Subperiosteal or subgingival abscesses are sometimes caused from difficult eruption, especially of the lower wisdom teeth, but malplaced cuspids and upper wisdom teeth may also give rise to an infection. In most cases the infection occurs after the gum has been pierced by the erupting cusps and may be due to food and fluids of the mouth entering through this wound. The soft tissue does not adhere to the enamel of the crown as it does to the cementum on the root by means of the peridental membrane and ligamentum circulare, and therefore foreign material is free to pass deep into the tissue around slowly erupting teeth, both impacted and normal. In other cases the infection is due more to irritation of the gum which is crowded over the occlusal surface during mastication and becomes bruised by the teeth of the

opposite jaw. In the back of the lower jaw where there is no natural drainage the pus accumulates and the inflammation often

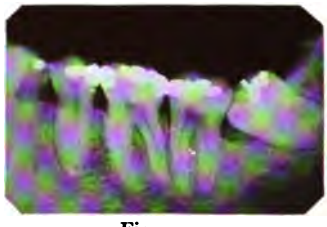


Fig. 152.

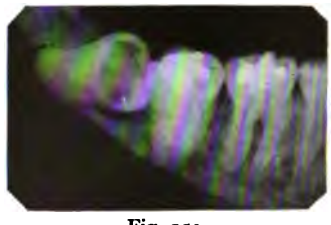


Fig. 153.

Fig. 154.

Fig. 155.

Fig. 152.—Roentgenogram showing partly erupted tooth which had become infected.

Fig. 153.—Roentgenogram showing an impacted lower third molar with a large cavity and a crown accompanied by infection, with a great deal of pus discharge around the tooth, swelling of the surrounding tissues, trismus of the muscles of the jaw, and difficulty in swallowing.

Fig. 154.—Roentgenogram showing two cuspids which have been partly eroded, due to an abscessed condition which was probably caused by an infection from the stumps of the remaining teeth. There was a great deal of pus discharge through a sinus on the palate.

Fig. 155.—Roentgenogram of an unerupted lower cuspid, showing erosion of the crown due to an abscess condition. There was a great deal of pain and swelling in the region of the lower lip. Pus was discharged through a sinus into the mouth.

involves the fauces, the mucous membrane, and the muscles about the ramus, a pharyngitis may set in, deglutition often becomes difficult, and trismus of the muscles of mastication is a common

occurrence and is sometimes so marked that the patient is unable to open his mouth. Fever, severe pain, and glandular enlargement are generally present, and I have seen cases where the abscess extended way down into the neck. Unerupted teeth may

Fig. 156.

Fig. 157.

Fig. 156.—Roentgenogram of an upper bicuspid with a gold crown. The pulp apparently has become infected and caused the blind abscess indicated by the black area at the end of the root.

Fig. 157.—Dry skull showing a similar condition and demonstrating the cause of the black area shown; namely, destruction of bone around the end of the root.

also become infected from abscesses on neighboring teeth (Figs. 152–155).

Dental Granulomata or Blind Abscesses.—In the last decade teeth have been devitalized for several reasons without realizing the danger of such proceedings, and the result of imperfect root canal work was not known until roentgenology was developed for

dental use. When the so-called areas of lessened density were shown in roentgenograms at the apices of devitalized teeth little attention was paid to them. They were considered a negligible quantity because the patient had no alarming symptoms of disturbance and often not the slightest discomfort. It was considered good dentistry to retain such teeth rather than lose an important organ of mastication, but since the pathology and bacteriology of these symptomless lesions have been studied more carefully and since the important discovery of focal infection, we

Fig. 158.—Photomicrograph of a tooth root with blind abscess or dental granuloma.

have come to realize the great fact that such septic conditions about the teeth may be more dangerous than the violent, acute conditions, principally on account of their deceiving nature and because they undermine the patient's general health.

The dental granuloma or blind abscess is caused by reaction of the peridental tissues to mild injurious agents such as bacteria in small numbers and of low virulence, bacterial toxins, or small amounts of necrotic tissue. It is characteristic of the lesion to start and continue to grow for a long time without the patient's knowledge and without symptoms of inflammation. It can be

compared with a circumscribed osteomyelitis. Inflammatory chronic new formation of tissue occurs at the apex of the root and grows at the expense of the bone (Figs. 158 and 159).

While granulomata occasionally attain large proportions, they usually remain about the size of a pea. The seat of chronic inflammation is surrounded by a fibrous capsule which extends into the medullary spaces between the trabeculæ of the bone. This is the reason why in most cases the granuloma is held back in the

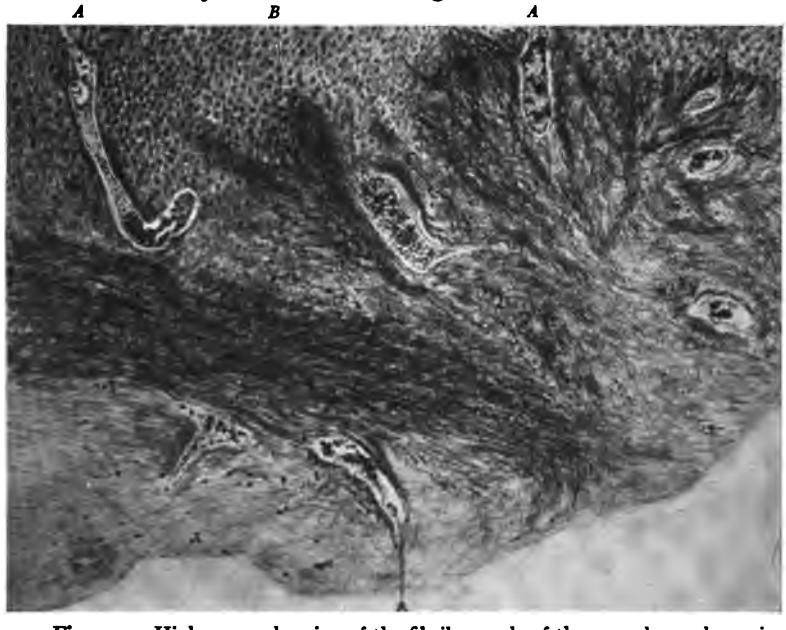


Fig. 159.—High-power drawing of the fibril capsule of the granuloma shown in Fig. 158, illustrating its fibrous make-up and penetration by many vessels: *A*, Vessels; *B*, inner part of granuloma.

jaw when the tooth is extracted. It is, however, occasionally connected so firmly with the peridental membrane that it stays attached to the extracted tooth. The thickness of the capsule varies greatly. The fibers are arranged in bundles and grow in various directions, as can be well demonstrated with special stains, such as Mallory's phosphotungstic acid—hematoxylin method (Fig. 159).

The study of the capsule impresses on us the great effort of

nature to wall off the seat of inflammation so as to prevent spreading into neighboring parts. It also demonstrates that this capsule does not prevent absorption, as it contains a meshwork of capillaries and is penetrated abundantly by larger vessels, thus establishing direct communication from the inner part, the seat of inflammation, with the circulation. Bacteria and toxins may, therefore, be carried away by the blood-stream (Fig. 159). The inner part of the lesion appears to be but one large mass of plasma

Fig. 160.—Photomicrograph showing a root end with a granuloma containing many dilated vessels crowded with red blood-corpuscles.

cells infiltrated in the inflammatory granulation tissue. Careful examination reveals capillaries which are often lined by only a single layer of endothelium and occasionally are extremely dilated and crowded with blood-corpuscles (Fig. 160). Polymorphonuclear and endothelial leukocytes and eosinophils may be found in large or small numbers according to the special condition which produced the tissue reaction. Quite frequently we find one or two places in the granuloma where necrosis has taken place, and a cer-

tain number of cells are seen detached from the rest and are more or less broken down. Polymorphonuclear leukocytes are then found in large numbers in the capillaries and in the tissue where the process of destruction is going on. The pus which is formed may be seen in the central part of the granuloma, which may contain also remnants of the decomposed tissue as well as

Fig. 161.—Photomicrograph showing large granuloma with pus formation in the center.

Fig. 162.—Photomicrograph showing root apex with a granuloma in which the suppurative process has broken through the capsule, forming a sinus.

inflammatory excretions from the pulp canals. The process of suppuration is seldom very severe and the pus is usually absorbed. Occasionally, however, the destructive process becomes more extensive, tearing down the fibrous encapsulation and forming a sinus to the surface of the gums or face (Fig. 162). The condition of the root end, which is always involved in this type of lesion, is of great importance. The cementum of the tooth, as a

rule, becomes denuded of the peridental membrane. It easily absorbs the products of inflammation and becomes infected, forming an obnoxious foreign body which nature tries to eliminate. Absorption starts at the surface and soon the cementum presents a rough appearance which is too minute to show in a roentgenogram. It is, however, easily recognizable under the microscope and due to osteoclastic absorption as seen in photomicrograph (Fig. 163). The absorption of the tooth root is very slow and

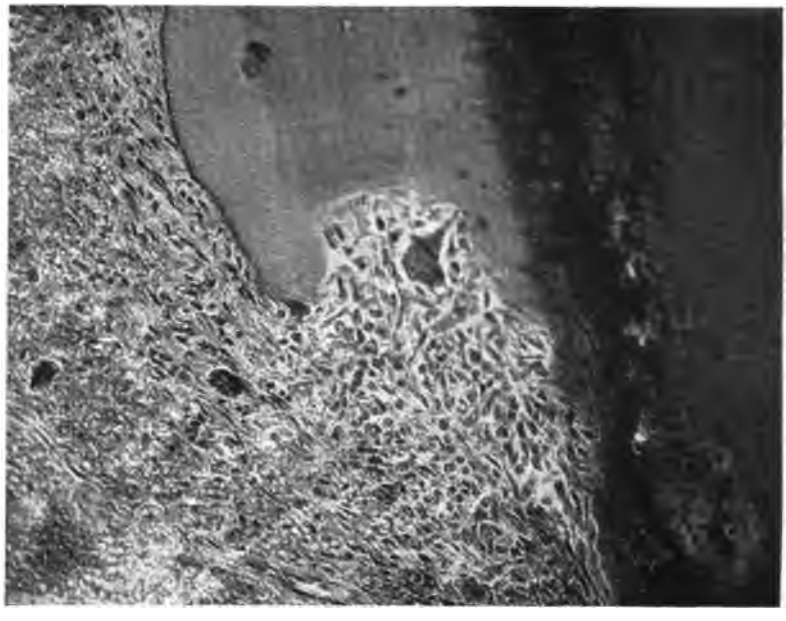


Fig. 163.—Photomicrograph with high power showing part of a root and granuloma. Note large osteoclast at the absorbed surface of the tooth.

differs somewhat from the same condition in the bone; there the dead part may finally become separated and expelled as a sequestrum, while in a tooth we find gradual absorption only of the root. It starts at the apex, and soon involves also the dentin (Fig. 164). This condition of the root apex is of the greatest importance when it comes to the treatment of such blind abscesses. There is to my knowledge no medicament, nor method, germicidal, oxidizing, or electrolytic, that will revivify a pus-

soaked, partly absorbed tooth apex, and as long as it exists it remains the cause of disease.

Periodontal or Radicular Cysts.—Remnants of epithelium of the embryonic enamel organs are commonly found in the normal peridental membrane, and therefore we may find them in the dental granuloma or blind abscess. The irritating influence of the chronic inflammation causes them to proliferate, and we

Fig. 164.—Photomicrograph of a root end with granuloma showing absorption of a large amount of cement and dentin.

Fig. 165.—Photomicrograph of an epitheliated granuloma showing band of epithelium proliferating through the granulation tissue.

therefore often find dividing and branching chains of epithelium which grow like a network through these lesions. In a section they show as bands of uneven thickness radiating in various directions. The cells of the proliferating epithelium become large, and the cytoplasm and nucleus grow more distinct. Leukocytes and plasma cells often invade the intercellular substance which loosely connects the various cells.

Cyst Formation.—If necrosis occurs in the center of an epi-

theliated granuloma, we find that the epithelial strands have a tendency to grow between live and necrosed tissue, sometimes giving the appearance of an endeavor to encapsulate the tissue which has become destroyed. Such epithelial linings may actually be found to cover the entire inner surface of the granuloma, which must be looked upon as the beginning of a periodontal or radicular cyst (Fig. 166). The exudates accumulating in the

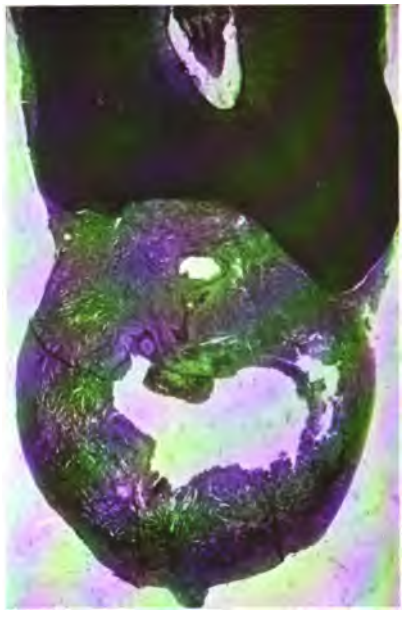


Fig. 166.—Photomicrograph of an epitheliated granuloma showing the beginning of a cyst. Epithelium is growing over part of the surface of the lumen. Note also rhomboid spaces due to cholesterin crystals.

lumen cause extension of the cyst, which may grow to the large size with which we are more familiar clinically. A careful study of the history and pathology of this type of bone cyst shows that they are of infectious nature. Roentgenographic examinations give further evidence of this by demonstrating that such cysts are almost always connected with a devitalized tooth except in cases where a tooth has been extracted without removing the epitheliated granuloma or the partly formed cysts (Fig. 167).

Pus Pockets and Pyorrhœa Alveolaris.—Pus pockets are quite frequently found on single teeth and are due to infection of the marginal part of the peridental membrane with involvement and destruction of the bone which forms the alveolar socket. They are caused by injury or irritation such as comes from poorly fitted gold crowns or fillings, from lack of contact between two

Fig. 167.—Roentgenogram of a jaw showing a large periodontal cyst. This was caused by a dead tooth which is seen extending into it and which has a root canal filling. The cyst contained pus.

teeth, causing food to crowd and stagnate in the interdental spaces, or from ligatures and rubber-dams left around the neck of a tooth.

Pyorrhœa alveolaris, or Rigg's disease, is a chronic condition of extremely frequent occurrence and usually involves all or nearly all of the teeth. It starts with inflammation of the gums, which may be due to local causes, such as lack of hygiene, aëration and

massage, and the irritating influence of salivary calculus or malocclusion, but frequently is brought about or associated with systemic disturbance, especially gastro-intestinal disorders, overfeeding, lack of exercise, gout, and diabetes. The inflamed and congested gums become relaxed and give access to the deeper tissues, namely, the peridental membrane and the alveolar bone

Fig. 168.

Fig. 169.

Fig. 168.—Photograph of a dry skull with pus pockets around the upper first bicuspid (the tooth in the center of the picture). This is probably due to lack of contact of this tooth with the neighboring one.

Fig. 169.—Roentgenogram of a similar condition caused by an ill-fitting gold crown. Note the extent of the pus pockets on both sides of the tooth.

which furnishes support to the teeth (Fig. 168). Infection soon sets in, the process being a chronic suppurative inflammation during which more or less serumal calculus is deposited at the sides of the teeth, which in turn increases the chronicity of the disease. The process of destruction proceeds, as a rule, in a longitudinal direction of the tooth, and therefore we find quite

frequently a very deep pus pocket at one side of the tooth, while at another the bone is normal. As the bone disappears,

Fig. 170.

Fig. 171.

Fig. 172.

Fig. 173.

Fig. 174.

Fig. 170.—Photograph of a dry skull showing pyorrheal affection. Note the destruction of the alveolar process on various teeth.

Figs. 171–174.—Roentgenograms of a mouth affected by pyorrhea. Note the absorption of bone around the teeth and deep pockets at various places. One bicuspid in Fig. 172 shows, in addition, a blind abscess or dental granuloma.

the tooth becomes looser and looser and so loses its functional efficiency (Figs. 170–180). The pus which is constantly formed

discharges into the mouth except in cases where the opening of the pocket becomes closed up. In such cases we quite frequently get the formation of an abscess which may take on an acute course, the pus collecting under the periosteum or under the gum. Bacterial infection is more or less accidental. There are always

Fig. 175.

Fig. 176.

Fig. 177.

Fig. 178.

Fig. 179.

Fig. 180.

Figs. 175–180.—Roentgenograms of various patients who suffered from maxillary sinusitis. Each picture is of a separate case, showing the condition of the upper teeth on the side of the infected antrum.

streptococci, staphylococci, and various bacilli, as well as many saprophytes present, of which the Treponema mucosum plays an important rôle. Noguchi discovered that this spirillum gives the peculiar odor to the pyorrhea pus. The Endamœba buccalis which has been found by Barrett and Bass is also often found in unclean mouths, but is of no etiologic importance.

The Mode of Distribution of the Infection in Oral Focal Disease.—1. *Disease Transmitted by Continuity.*—The surrounding structures of the oral cavity may become infected from infections of and about the teeth. Necrosis of the palatal bones, abscesses in the floor of the mouth and in the pharynx are liable to occur, while infection of the nose and especially the maxillary sinuses is a very common trouble.

2. *Infection of the Gastro-intestinal Tract.*—Dental abscesses with sinuses and pus pockets discharging into the mouth where the pus mingles with the saliva and food during mastication cause infections of the throat and reach the stomach and intestines, giving rise to most serious diseases of the mucosa of the alimentary canal. For a long time the acids of the stomach have been looked upon as destructive to such bacteria, but Smithies,* in a microscopic examination of gastric extracts from 2406 different individuals with "stomach complaint," showed that, irrespective of the acidity of such gastric extracts, bacteria were present in 87 per cent. Hunter says there is a limit to the power of the stomach to destroy such organisms. Even in health it is never complete and is solely due to the presence of free HCl. But these powers become progressively weakened when, through any cause, an increased and continuous supply of pus organisms is associated with a diminished and continually lessening acidity of the gastric juice.

3. *Lymphogenous Infection.*—Lesions of the oral cavity are quite often associated with secondary infections of the lymphatic vessels and lymph-glands of these parts. There are two groups of lymph-glands which drain the jaws and teeth and their mucous membrane. The submental glands take care of the region of the lower incisor teeth. Still more important because of the greater frequency of their involvement are the submaxillary lymph-glands. They are three in number and drain the rest of the teeth and their investing tissue. All of them are tributaries of the lymph-nodes of the neck. The submaxillary lymph-glands, which are hardly noticeable when in normal condition, become quite frequently involved. The reaction varies in character ac-

* Cited from Mayo: Mouth Infection as a Source of Systemic Disease.

cording to the virulency and character of the invading bacteria. Lymphatic infection occurs most often in children, but is not at all rare in adults. The entrance of the tubercle bacillus by way of the teeth is, perhaps, more common than we think, Professor Cantani, of Naples,[4] has reported 50 clinical cases of tubercular infection of these lymph-glands through the teeth.

Hematogenous Infection.—Today we know that infections are never entirely localized. Bacteria, their toxins, and bacterial poison produced during the process of infection and inflammation, or both, are always absorbed into the circulation, not only from the primary focus but also from secondary lesions. The presence of bacteria and of protein poisons in the blood may cause diseases of violent and acute symptoms, but more frequently cause secondary disturbances of latent and chronic character and many lesser ills, such as malaise, fatigue, and other subjective symptoms, soreness of joints, muscles, and nerves. Lesions without any direct outlet, such as blind abscesses and periodontal cysts, are very liable to be the source of hematogenous absorption.

4. *Oral Infection as an Indirect Factor.*—The fact that a coexisting infection in the mouth may be a considerable burden on a body weakened by some other disease has already been discussed and clearly illustrated in the charts in Figs. 150 and 151. The continuous fighting of the infection and elimination of the poisons produced must be a great tax on the organs whose function it is to combat disease. Therefore, for this reason alone we should search for and eliminate diseased conditions in the mouth in order to raise the resistence and improve the patient's general health.

6. *The Teeth as a Source of Subjective Symptoms of Pressure and Nervous Disorders.*—The extensive area of distribution of the trifacial nerve and its frequent communications with other cranial nerves and the sympathetic system explains the clinical observations that pain and irritation originating from some dental or oral cause may be referred to very distant parts of the face and head, including the ear (otalgia dentalis), the eye, the nose, and accessory sinuses. Such pain may be continuous, intermittent, or periodic; it may be intense, sharp, throbbing,

or dull, and it may be a sensation of obscure, indefinable pressure. It sometimes results in more serious nervous disorders, such as insomnia, melancholy, and epilepsy. The suffering that goes with these affections is usually intense, especially if it has lasted any length of time and the cause is often difficult to ascertain and involves a most careful study with temperature and electric tests, as well as extensive and painstaking roentgenographic examination. The most important causes are impacted and unerupted teeth, obscure pericemental inflammation and affections of the dental pulp, such as irritation from improper filling, pulp nodules or stones, infection from obscure decay, either starting underneath the gum or continuing after a tooth has been filled, due to insufficient sterilization.

SPECIAL AND GENERAL DISEASES WHICH MAY ORIGINATE FROM SOME ORAL CONDITION

In the following list I have tried to enumerate some of the special and general diseases which may have their origin in the oral cavity. It may not be amiss, however, to state here that I do not mean to imply that diseases of the teeth are the only or even the most important etiologic factor in all these disturbances. Neither have I presumed in compiling this list to collect all the claims that have been made for focal infection in general and dental lesions in particular, but have aimed to be conservative.

Laryngology, Rhinology, and Otology.—*Maxillary sinusitis* in its various forms is much more frequently due to a dental infection than has heretofore been supposed (75 per cent. according to Brophy). Its chronic form develops quite frequently without the patient's knowledge and often is only discovered by accident. The upper molars and bicuspids should be roentgenographed in all cases of maxillary sinusitis, and the dentist should in turn advise his patient to have his sinuses investigated should he find suspicious upper back teeth.

Nasopharyngeal adenoids are often caused by mouth-breathing and malocclusion of the teeth, and particularly by narrow and compressed arches.

Tonsillitis and *pharyngitis* may be caused by oral sepsis.

Otalgia Dentalis.—Referred pain may be due to a cause in the upper or lower jaws.

Otitis media sometimes has a referred nerve irritation from a dental condition as a predisposing cause.

Ophthalmology.—Ophthalmic disturbances due to oral conditions may be brought about in either of two ways, through nerve irritation or through hematogenous infection.

Infectious conjunctivitis in children may be caused by carrying the infection with the fingers from an infected aching tooth to the eye.

Acute iritis can be caused by nerve irritation or hematogenous infection from the nose or mouth.

Chronic iridocyclitis and *choroiditis* are usually combined with iritis.

Keratitis also comes from direct and indirect infection.

Retrobulbar neuritis occurs from hematogenous infection or from infection of ethmoids or sphenoids.

Orthopedics.—*Infectious arthritis, acute* and *chronic*, are now accepted as being due to focal infection. The nasopharynx, the oral cavity, and the gastro-intestinal tract are supposed to be the most important sites of the focus. Cases of acute multiple arthritis from a dental cause are not uncommon. Cause and effect can be ascertained more easily in this type of arthritis, especially as the removal of the focus is almost always promptly followed by disappearance of the disease, which may be preceded, however, by an exacerbation. In the subacute and chronic types of the trouble the result, as a rule, is not so gratifying. The joints themselves are often a secondary focus, from which the infection may be further transported, while quite frequently they show tissue changes which are beyond repair from an anatomic point of view. The removal of the focus, however, usually relieves symptoms of pain and swelling from subacute conditions and prevents reinfection from this source.

At the Robert Breck Brigham Hospital for chronic disease the treatment of chronic arthritis is directed toward improvement of the functional efficiency of the patient. To achieve this the patient's general health is first built up not only by dietary

measures, but by the removal of any infectious lesions and the correction of all abnormal conditions which may lower the patient's resistance and prevent improvement of his condition.

Pediatrics.—*Acute rheumatic infection* in children, including *endocarditis* and *nephritis*, may be caused by foci in the nose and throat or by dental infection.

Arthritis may come from foci in the same location.

Lymphadenitis in the glands of the submaxillary region and neck often occurs from infections about the teeth, including the entrance of the tubercle bacillus through this channel.

Nervous and abnormal *mental conditions* are often found which are due to pressure from impacted teeth.

General Medicine.—*Septicemia*, *pyemia*, and *toxemia* may be caused by diseases of the teeth and jaws, but are of comparatively rare occurrence, while a great many vague medical conditions, due to absorption of a slight amount of toxin or bacteria, are exceedingly common. A perfectly healthy person may be able to eliminate this daily dose, but, as a rule, sooner or later a condition arises which brings about more serious results. Lowering of the body temperature by exposure to cold or wet may bring about more or less vague rheumatic conditions of the muscles, joints, and nerves. Other expressions of chronic toxemia are frequently occasioned by diseases of the teeth and jaws, that is, disproportionate fatigue from slight exertions, inability to do the accustomed day's work mentally or physically, benumbed mental activity, requirement of an abnormal amount of rest, loss of weight, grayish, sallow skin, and a rise in the temperature in the afternoon or evening. Leukocytosis and secondary anemia are also often observed.

Endocarditis and *nephritis* caused by focal infection may have their etiologic factor in the mouth. In heart infections we must consider, in addition, the danger and additional strain on the heart caused by toxic absorption and its elimination, as has been demonstrated in some of the charts.

Gastro-intestinal disorders caused by pus from the nasopharynx or mouth include, according to many writers, septic gastritis, appendicitis, colitis, and gastric and duodenal ulcers.

Ductless Glands.—Toxemia from oral sepsis may affect the glands of internal secretion, and it is conceded that overstimulation by the toxins may produce symptoms of hyperthyroidism. High blood-pressure and the resulting circulatory disturbances are caused by the same toxic condition, affecting directly or indirectly through the glands of internal secretion the vegetative nervous system controlling the vasomotor system.

Neurology and Psychiatry.—*Affections of the trigeminal nerve* and referred pain to the nerves with which it communicates may be due either to dental lesions or conditions exerting pressure.

Melancholy, mental depression, insomnia, and similar symptoms of more or less obscure nature may likewise be associated with some hidden dental condition, as has already been described in another place.

THE IMPORTANCE OF INVESTIGATING THE MOUTH

All this demonstrates the importance of dental research work, which will develop dental science along therapeutic lines, while heretofore it was principally concerned with perfecting mechanical skill. Also it will bring about its proper relation to medicine, to which it is naturally allied, and of which it should form a department like other specialties.

It further brings out the importance of the service which properly trained dentists can render the internist by intelligently examining the mouth of a patient, with the knowledge in mind of its relation to somatic diseases.

The relation of dentistry to other specialties is of the same importance. The dentist should consider the condition of other parts, especially adjoining ones, the nose, throat, and sinuses, while in diseases treated by other specialists the etiologic or complicating factor may be found in the mouth.

A short description of the pathology of some of the more common dental diseases was added to show that they are a special study in themselves of numerous different clinical aspects arising from a variety of causes, and that their correct diagnosis requires special training. The statements encountered in the literature which sets forth the fact that in a certain disease the teeth were in

so many cases good, in so many fairly good, and in the rest bad gives us as little information as would statistics showing that a certain number of patients were in poor health and another number were in fairly good condition.

I have also intended to show that foci in the mouth, as well as in the adjoining parts, the nose and throat, may be manifested only by remote general symptoms, and that if such symptoms indicate focal disease, pathologic conditions of the teeth and jaws should be suspected, and, like other parts, the mouth should be carefully investigated.

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PATHOLOGIC HEMORRHAGE

A Group of Cases Illustrating This Condition with a Note on the Early Diagnosis of Pernicious Anemia.

The Methods of Demonstrating the Abnormalities Associated with the Coagulation of the Blood; The Importance of the Blood Platelets; Chronic Congenital Purpura Hemorrhagica; Its Distinction from Hemophilia; Idiopathic Acute Purpura Hemorrhagica and Its Distinction from Aplastic Anemia; Purpura Rheumatica and Its Diagnosis from Purpura Hemorrhagica; Early Tongue Symptoms of Pernicious Anemia; Secondary or Symptomatic Purpura Hemorrhagica; Bibliography.

I WISH to show you a group of hemorrhagic cases and to discuss somewhat the methods of demonstrating the abnormalities associated with the coagulation of the blood. I wish to lay particular stress on those cases with diminished blood platelets—cases of purpura hemorrhagica—and on the importance of these small formed elements of the blood.

In the study of the blood the only formed elements which receive attention, as a rule, are the red cells and the white cells. The third formed element of the blood, the blood platelet, has received relatively little attention. This element has very positive and important features, and there are certain conditions attributable to its pathologic alteration. The platelets have been recognized as separate entities of the blood since Bizzozero and Hayem in the '80's first worked with them. They are, as shown by Wright, fragmented particles of protoplasm derived from the giant cells (megakaryocytes) of the blood-forming

organs. They undergo a peculiar viscous metamorphosis when the blood clots.

Hemorrhagic conditions due to a recognized abnormality of the blood are associated with a diminished number of platelets, or with alterations of these elements, or of other factors involved in the coagulation of the blood, and are in some instances perhaps dependent upon a fibrinolytic ferment. The various types of purpura hemorrhagica, hemophilia, melena neonatorum, the hemorrhages occurring in certain liver conditions belong to this group. Such cases may have spontaneous hemorrhages from one or more mucous membranes of the body, or an undue amount of hemorrhage following injury, or hemorrhages into the skin, muscles, joints, or other tissues. There are certain cases that have hemorrhages into the skin, but do not have hemorrhages from the mucous membranes or an undue amount of hemorrhage following an injury, which show no recognized abnormality of the blood, for example, purpura rheumatica and purpuras caused by drugs. There are cases of endocarditis that develop purpuric-like areas, particularly on the hands, that are due to bacterial embolism and are not attributable to alteration of the blood-coagulation factors. Scurvy is essentially the only condition where there may perhaps occur spontaneous mucous membrane hemorrhages with no clear-cut recognized abnormality of blood coagulation. Hemorrhage from chiefly or entirely one source is not infrequently considered as due to some blood abnormality, but with a careful study of the case it is usually found that the hemorrhage is due to local conditions and is not dependent upon any general condition of the blood.

A careful study of the blood should be undertaken in all hemorrhagic conditions. This careful study should particularly include, properly performed, the following tests: enumeration or estimation of the platelets, coagulation time, bleeding time, firmness, and retractability of the clot. In many cases with pathologic hemorrhage these tests will yield positive information. Before I take up the cases I will discuss somewhat these tests.

1. *Enumeration or Estimation of the Blood Platelets.*—Normally the blood platelets in man vary between 200,000 and

400,000 per cubic millimeter, averaging about 250,000. When they are below about 60,000 spontaneous bleeding usually occurs, and when below 20,000 bleeding always occurs. The platelets may be counted by Wright and Kinnicutt's method or by Pratt's, in a manner similar to that used in counting the red and white corpuscles. The technic is, however, more bothersome and it requires considerable experience to make a reliable count of these elements. One with some experience may in a shorter time and more easily derive sufficient information for the purposes of diagnosis from a simple estimation of the number of platelets from blood-smears instead of by an actual count. By so doing one can tell whether they are greatly or somewhat increased, about normal, somewhat, markedly, or greatly diminished. Neatly and quickly made blood-smears properly stained with one of the modifications of Romanowsky's stain, preferably Wright's modification, will serve to estimate the platelets as one may similarly estimate the white count. However, we much prefer to estimate the platelets from a smear of fresh blood stained with brilliant cresyl blue because the platelets are more readily seen as separate objects than in the fixed preparation, and with this stain their granules and structure become evident. It is exceedingly simple to stain blood with cresyl blue, and may be done as follows: A fresh watery solution of 1 : 300 of this dye is allowed to dry on a glass microscope slide; once the stain has dried, it keeps indefinitely. A drop of blood is obtained on a cover-glass and quickly inverted on to the dried cresyl blue on the slide, so that the blood spreads out between the cover-glass and slide. The blood dissolves the stain and the platelets are stained blue. This method of staining is also very valuable for demonstrating the reticulated red cells or skeined cells, which are young red cells and normally form about 0.7 per cent of the red cells. These cells are not demonstrable as such in ordinary fixed and stained smears.

2. *The Bleeding Time.*—This is determined by simply pricking the ear with a clean, sharp needle and wiping upon blotting-paper every one or two minutes the drops that form, noting the time it takes for such a hemorrhage to cease. Normally such a

hemorrhage ceases in less than three minutes, and the drops rapidly diminish in size. In extremely abnormal cases such a hemorrhage may last for even hours unless suitable means are taken to check it. It is to be noted that the bleeding time, this tendency to bleed from fresh cuts, is independent of the coagulation time. One of the factors on which the bleeding time depends is the platelets. Roughly, the fewer the platelets below 125,000, the longer the bleeding time. There are, however, other factors which influence the bleeding time, as diminished amounts of fibrinogen.

3. *The Coagulation Time.*—This should be determined by some method that causes as little admixture of tissue juice as possible, because this substance which has a similar action to the blood platelets is very potent in accelerating coagulation. Thus, it is highly desirable to determine the coagulation time from blood derived from a vein, as of the arm, rather than through the tissues, as from the ear. A very suitable method for determining the coagulation time is that originally described by Morawitz and Bierch, and modified by Howell, Dochez, and Lee and White. Lee and White's method consists in determining the time it takes 1 c.c. of venous blood to just clot firmly in a clean glass tube that is 8 mm. in diameter so that the tube can be inverted without spilling the blood. By this method normal blood clots in from five to ten minutes. Variations in the amount of blood or size of the tube will, of course, cause variations in the coagulation time; also admixture of air, undue trauma, etc., hasten the coagulation time. Besides determining the time it takes the blood to clot firmly and throughout the sample, it is desirable to observe the time it takes for the first signs of coagulation to appear—that is, when the first fibrin strands begin to form or when the blood first begins to become thicker. This is because in some conditions the blood begins to clot in normal time, but does not completely clot for a longer time than normal. This is probably due to a slow rate of formation of thrombin or a diminished thrombin or fibrinogen content. Such a phenomenon is probably related to the reclotting phenomenon. This consists of noting whether the fluid surrounding a firm clot will

itself clot after the clot has been removed from the tube. Usually some minutes before complete coagulation one will observe that the upper surface of the blood has begun to clot. This superficial coagulation may be great enough to prevent the fluid blood beneath from running down the tube when it is tilted, and in such instances it is not uncommon to see a bubble of air travel through the fluid blood. One must thus be careful not to mistake such surface coagulation for complete coagulation. There are other methods perhaps preferable for determining the first signs of coagulation, but the one given serves very well for ordinary clinical purposes.

It may be noted here that the length of the coagulation time does not run parallel with the tendency to hemorrhages, for there are certain cases of hemophilia that bleed severely when the coagulation time is about twenty minutes, and others that do not do so when the coagulation time is one hour.

4. *The Firmness and Retractability of the Clot.*—Two other observations should be made on the clot—its firmness and retractability. A weak clot is associated with diminished amount of fibrinogen or thrombin. Normally the clot continues to retract from the sides of the glass tube for a period of hours and expresses serum. When the platelets are greatly diminished in number the clot never retracts at all. The degree of retraction is roughly proportional to the number of platelets.

The tests that I have mentioned are the most important ones for establishing the diagnosis of hemorrhagic conditions.

Besides these tests the following ones are valuable under certain conditions, but we will have no special reference to them in discussing the cases that I will presently show you. These tests are: 1. The effect of suitable amounts of calcium on the coagulation time and prothrombin time. 2. Determination of the prothrombin time, which is to determine the time it takes a sample of oxalated plasma to clot with the optimum amount of calcium. 3. Determination of antithrombin. 4. Determination of fibrinogen. 5. Determination of the presence of a fibrinolytic ferment.

Besides these laboratory tests on the blood, a clinical test

probably of some value in hemorrhagic diseases is to determine the effect of placing a tourniquet around the arm for some minutes and observing whether it causes any hemorrhages, large or small, superficial or deep, below the point of constriction. I will not discuss this test, but it may be noted that in hemophilia such pressure does not cause superficial hemorrhagic spots, while in purpura hemorrhagica it usually does so.

Let us now briefly consider the character of purpura hemorrhagica in the light of these laboratory tests and in its clinical features, and then I will show you cases of some of the types of this condition and discuss particularly how they differ from hemophilia, aplastic anemia, and purpura rheumatica.

Purpura hemorrhagica is a condition in which there is bleeding from one or more mucous membranes and usually purpuric skin lesions. In purpura hemorrhagica there occurs a marked diminution of the blood platelets, a prolonged bleeding time, and a normal or slightly delayed, rarely much delayed, coagulation time, and a non-retractile blood-clot that is usually soft. Purpura hemorrhagica is not to be confused with the other types of purpura, which have essentially a normal number of platelets and no definite alteration of their coagulation factors. Purpura hemorrhagica may be an idiopathic disease or appear as a symptom secondary to some recognized disease as pernicious anemia, lymphatic leukemia, diphtheria, tuberculosis, etc.

The idiopathic type may occur in the following forms: 1. Continuous, acute or chronic, acquired or congenital. 2. Intermittent. In the former the platelets are continuously below normal, while in the latter they are below normal during the attacks only. It is quite probable that the very chronic types, which are apparently often congenital, are of a different etiologic nature than that of the more acute types, though we have no real knowledge of the etiology of these conditions.

The case which I now present is an example of chronic, essentially continuous, congenital purpura hemorrhagica, which is so often confused with hemophilia. The condition is rare, but apparently not extremely so. During the past year we have observed 4 new cases at the Massachusetts General Hospital.

CASE 1.—The patient is a farmer twenty-two years of age who gives the following summarized history: His grandparents lived to be over sixty years of age, and his mother, father, brothers, and sisters are living and well. There is no family history of hemorrhagic disease. Except for measles, which was severe, he has had no infectious diseases. Off and on ever since he was born he has had nosebleeds and has had considerable difficulty in stopping them. Occasionally he has had slight bleeding from his gums. During his life he has always bled very profusely from small cuts. He got along very well until two years ago, when the nosebleeds became more frequent, occurring two or three times a week instead of only every few weeks, lasting often for three hours. Three weeks ago he had a severe nosebleed which lasted for three days; since then his nose has bled slightly every few days, but not within the past five days. During the past two weeks he has suffered from headache, ringing in the ears, palpitation, faintness, and slight dyspnea, and during this time he has grown paler. Never before has he felt sick or has he had to give up work or school. There has been no bleeding from other mucous membranes than those of the nose and mouth.

The physical examination shows a big framed man, appearing somewhat pale. The skin shows a long hemorrhagic scratch area over the upper chest, some very small petechiæ on the lower legs, and two superficial purpuric areas the size of a pea over the left abdomen, and two similar areas on the skin of the left side of the neck. On the upper arm is a deep ecchymotic area about 3 by 5 cm. which developed following slight trauma. The gums showed several minute hemorrhagic spots. The teeth are intact. Except for the above and a functional heart murmur the physical examination is entirely negative. The urine, stool, and Wassermann reaction are negative.

The blood examination shows the following: Blood platelets, 55,000; bleeding time, seven to ten minutes. The complete coagulation time, thirteen minutes; the initial coagulation began in six minutes; the clot does not retract. Hemoglobin 55 per cent. Red count 3,400,000. White count 9000; the differential

count shows polymorphonuclear neutrophils 54 per cent., lymphocytes 38 per cent., mononuclears 7 per cent., mast cells 1 per cent. The red cells in general are small and achromic; they show some variation in size and a little variation in shape, Polychromatophilia occasionally occurs. The reticulated red cells are 7 per cent.

The application of a tourniquet to the arm for five minutes produces numerous fine petechiæ on the arm considerably below the point of pressure.

The symptoms that he has had in the past two weeks are entirely attributable to the secondary anemia which has resulted from his hemorrhages. It is interesting to note that he says that he had measles severely, for when these cases have one of the exanthemata they usually do have them severely because the eruption is apt to become hemorrhagic due to their constant low platelet count.

This case could be diagnosed from the history and from the evidence given by the examination of the patient's skin at the present time even if no laboratory blood examination had been made. This is because there are but two hemorrhagic diseases that exist from birth—chronic congenital purpura hemorrhagica and hemophilia, and in hemophilia one never sees small superficial skin petechiæ. The blood examination, however, should always be made for its confirmatory evidence in such a case as this one, but in many others it is necessary for the diagnosis. (Another rare hemorrhagic condition especially causing nosebleeds is familial telangiectasis, but here we find a local cause for the hemorrhages.) Hemophilia was the diagnosis this patient was sent to the hospital with, but his condition is definitely to be distinguished from hemophilia. In hemophilia the blood-platelets occur in normal or slightly increased numbers, though they are physiologically or qualitatively defective; as pointed out by Fonio and Dr. Lee and myself, while in purpura hemorrhagica they are much decreased. In hemophilia the coagulation time and particularly the prothrombin time are nearly always much prolonged, while in purpura hemorrhagica these times are often normal and rarely much delayed, and never more than

slightly delayed in the congenital type. The blood-clot in hemophilia is firm and retracts in normal fashion, while it does not retract and is soft in purpura hemorrhagica. The bleeding time in hemophilia is usually essentially normal, while it is prolonged, not infrequently much prolonged, in purpura hemorrhagica. Superficial purpuric skin lesions do not occur in hemophilia, but do in purpura hemorrhagica. These lesions in purpura hemorrhagica may be very scant and minute and require careful inspection to discover them, and, too, they may be absent at any one given time. Big areas of ecchymosis, usually rather deep, do occur in hemophilia, and similar areas may occur in purpura hemorrhagica; in fact, most of our cases of congenital purpura hemorrhagica have shown especially on the extremities one to five hemorrhagic ecchymoses, usually rather superficial, with often a lump in the center probably due to the blood-clot. It would seem as if the cases of chronic purpura hemorrhagica apparently never had as extensive skin lesions as may occur in the more acute forms. The tourniquet does not cause petechiæ to appear in hemophilia, while it does usually cause them to appear in purpura hemorrhagica. Joint symptoms are common in hemophilia due to hemorrhage into the joints, and are rare in purpura hemorrhagica. Another most important point in the differential diagnosis of purpura hemorrhagica from true hemophilia is that hemophilia is hereditary through females and occurs in males only, while purpura hemorrhagica occurs in females as well as in males. There are certain cases of hemophilia where no family history of the disease is obtained; perhaps this is because the patient has no knowledge about his grandparents. In our series of cases there have been more females than males that have had this congenital type of purpura hemorrhagica. In women the presenting symptom may be excessive menstruation. Certain cases described in the literature as vicarious menstruation have undoubtedly been cases of chronic purpura hemorrhagica.

In regard to the prognosis of this type of case as compared to hemophilia I am at present unable to tell you, as such cases as these have not been followed long enough. There is perhaps some information to suggest that these cases become severer as

the patient grows older, while hemophiliacs appear to suffer less as they grow older.

The second case that I wish to show you is one of acute idiopathic acquired purpura hemorrhagica.

CASE 2.—The patient is a girl of eighteen. The history is negative except for the following: Six weeks ago she began to bleed from the nose and has continued to do so off and on since. During the past two weeks she has had continual vaginal flow and for the past week has noticed spots on her body. She has grown steadily paler and weaker. The physical examination reveals nothing of interest beyond the following: The patient looks pale and sick and has a temperature of 101° F. and a pulse of 100. There are scattered all over the skin, particularly on the lower legs, some fresh and some old, superficial, not raised purpuric areas varying in size from 1 mm. to 2½ cm. A few petechiæ appear on the mucous membranes of the mouth, and blood is oozing from the nose. The blood: The platelets as estimated from cresyl blue smears are exceedingly rare, about 5000 to 10,000. The bleeding time is forty-five minutes. The coagulation time and prothrombin time are slightly prolonged. The clot is soft and non-retractile. The red count is 1,300,000 and the hemoglobin about 25 per cent. The red cells show some achromia, considerable variation in size and shape, though no very large abnormal shaped cells occur, occasionally a normoblast is seen, and there is some polychromatophilia and stippling. The reticulated red cells are 10 per cent. The white count is 10,000; the polymorphonuclears 68 per cent.; lymphocytes 22 per cent.; mononuclear cells 10 per cent. Blood-cultures, Wassermann reaction, stools, urine, and other laboratory tests showed nothing of interest except for a small amount of fresh blood in the urine.

The diagnosis of purpura hemorrhagica is established by the marked diminution of the platelets. The case is of the idiopathic type because we find nothing for the condition to be secondary to. Such severe cases as this nearly always run an acutely fatal course and die some weeks to months after the onset of the disease. Those cases living for months have fluctuations in the intensity of the bleeding parallel with the rises

and falls in the number of the platelets, though these elements never reach normal. Some cases may have several attacks of purpura some months or years apart, with diminution of the platelets only during the attack, the earlier attacks usually being milder than the later ones. Such cases are known as the intermittent form of purpura hemorrhagica. Other cases may have mild attacks without recurrence. (This case continued to get steadily worse, bled from all mucous membranes, and died eight weeks after the onset of the disease. She refused to be transfused and no autopsy was permitted.)

It is to be noted that this patient shows a severe secondary anemia due to the hemorrhages. The blood-picture is that of secondary anemia following direct hemorrhage in a normal individual except for one important point, and that is that the platelets are not increased. So far as the red cells are concerned they have the characters of those of such an anemia and show evidence of regeneration, as evidenced by the increase of reticulated red cells and the presence of blasts and polychromatophilia. The polymorphonuclears are increased as occurs in the anemia following hemorrhage. In other words, we have evidence of activity of the red and white cell elements of the bone-marrow, but not of the giant cells of the marrow, the parent cells of the platelets. It is, however, quite possible that the platelets are formed readily enough, but that the difficulty is that they are rapidly destroyed in the circulation. There is some evidence that this may be the case because the marrow in cases like this may show plenty of giant cells and appear, as a whole, hyperplastic.

This observation on the activity of the marrow, as evidenced by the red and white cells, is important in distinguishing this and other acute cases of purpura hemorrhagica from idiopathic aplastic anemia, which has undoubtedly often been confused with it. Idiopathic aplastic anemia is a disease which runs an acute, progressively downward, fatal course of about three to six weeks' duration and characterized by absence of blood regeneration of any of the three formed elements originating in the marrow—the red cells, polymorphonuclears, and platelets. The marrow of such cases at autopsy is not hyperplastic, but typically shows

complete fatty degeneration. The red cells show no or very little evidence of regeneration, as evidenced by their slight variation in size and shape, the absence or rarity of polychromatophilia, blasts, and reticulated red cells. The white count is much diminished with a relative lymphocytosis, thus showing little or no regeneration of the white cells originating in the marrow. The absence in the peripheral blood of evidence of regeneration of the red and white cell elements is in contrast to the finding in cases of purpura hemorrhagica of regeneration of these elements. In common with purpura hemorrhagica the platelets are reduced because in aplastic anemia the megakaryocytes, the parent cells of the platelets, are destroyed along with the destruction of other cells of the marrow. It is to be noted that usually in aplastic anemia the anemia is evident early; gradually the platelets become fewer until reduced to so small a number that bleeding occurs; that is, it occurs relatively late in the disease, while typically in acute idiopathic purpura hemorrhagica bleeding occurs early. When purpura hemorrhagica has developed in a case of aplastic anemia we then rather arbitrarily call it secondary purpura hemorrhagica. It may well be that these two conditions, aplastic anemia and idiopathic purpura hemorrhagica, are not so distantly related, as is perhaps shown by the fact that cases may be recognized that appear to form an intermediate type of condition between them and suggest a partially depressed activity of the marrow especially involving the platelet elements. I have recently discussed this question in the Archives of Internal Medicine, 1917, xix, 1062.

In purpura hemorrhagica, primary or secondary, we may note that diminution of the platelets may be due to: 1. Destruction, depressed activity or exhaustion of the megakaryocytes (with or without similar action on the other elements of the marrow) by some unrecognized or recognized toxin or poison, as benzol, or by congenital absence of these elements. 2. Destruction of the platelets in the circulation. 3. Displacement of the megakaryocytes by abnormal cells.

Certain cases of acute lymphatic leukemia may present a history not unlike the case I have just shown you of idiopathic

purpura hemorrhagica, but the blood examination reveals leukemia, and the marrow at autopsy shows a crowding out of the megakaryocytes by the leukemic cells so that a secondary purpura hemorrhagica develops. A similar condition may exist with metastatic tumors, pernicious anemia, etc.

I now wish to show you another case of purpura that is not dependent upon reduction of the blood platelets or demonstrable alteration of any of the other elements of coagulation.

CASE 3.—The patient is a man, thirty-four years of age, who gives the following summarized history: A year and a half ago he had an attack of tonsillitis. Since then he has been well until five days ago, when he developed considerable pain with slight swelling and tenderness in his kness, then his ankles and elbows. Three days ago there developed all over his body except upon his hands and face a rash. The physical examination shows rather uniformly all over the body except upon the hands, face, and upper legs discrete purpuric macules and papules of from 2 to 5 mm. in diameter. The lesions are perhaps rather more marked about the joints. There are no deep ecchymoses, and no evidence of bleeding from the mucous membranes. The joints appear as he described them. The tonsils are enlarged and red. The heart is negative. The temperature is 101° F., the pulse 100; otherwise the physical examination is negative.

The laboratory examinations are negative, including a blood-culture, and a culture from a purpuric skin lesion which showed no growth. The blood examination shows that the platelets, bleeding time, coagulation time, and retraction of clot are normal. The red count and hemoglobin are normal. The white count is 8000 and the differential count essentially normal.

The case is one of purpura rheumatica, and although there are purpuric lesions on the skin, there are no hemorrhages from the mucous membranes, and there is no tendency to bleed, as occurs in purpura hemorrhagica. The reason for the purpuric skin lesions is unknown. I show you the case because one of the presenting symptoms is purpura and because the condition is to be sharply differentiated from purpura hemorrhagica.

Purpura rheumatica seems more closely related to cases of infectious arthritis than to the clear-cut types of hemorrhagic diseases. The joint symptoms are in all probability not due to hemorrhage into the joints. Purpura rheumatica appears like ordinary rheumatic fever plus purpura. There is, however, considerable evidence that the condition is not ordinary rheumatic fever, because the joint symptoms are usually mild, fever is often absent or slight and rarely high, and because endocarditis rather rarely occurs, and in clear-cut cases of rheumatic fever purpura is exceedingly rare. However, it would seem as if purpura rheumatica was due to some infection which produces a type of infectious arthritis, but one that may be different from that of rheumatic fever. The purpuric lesions are apt to recur in successive crops with or without the recurrence of the joint symptoms. The cases usually get well.

You will note that the blood findings in this as in other cases of purpura rheumatica are negative, which is in contrast to the findings in purpura hemorrhagica. Some cases of purpura rheumatica may develop, as do ordinary cases of rheumatic fever, a considerable secondary anemia, but this is not dependent upon hemorrhage, but presumably upon the toxemia. In such instances the platelets will often be found actually increased, as occurs so frequently in secondary anemia. Joint symptoms in purpura rheumatica are relatively prominent as compared to the purpura, and it is on account of these that the patient generally seeks relief and usually not especially for his purpura, which latter is the reason why the cases of purpura hemorrhagica seek relief. Also it is to be noted that joint symptoms usually do not occur in true purpura hemorrhagica.

In purpura hemorrhagica one never sees as extensive purpuric skin lesions as this case of purpura rheumatica presents without there being bleeding from the mucous membranes. It is perhaps unusual to have in purpura hemorrhagica such a generalized purpuric eruption as Case 2 presented. One not infrequently finds but a few scattered petechiæ as occurred in Case 1. However, many cases of purpura rheumatica do not have more than a few purpuric skin lesions, and if so, they are often sit-

uated in particularly one part of the body, perhaps especially about the joints.

Another point which has seemed to me to distinguish purpura rheumatica from purpura hemorrhagica is the character of the purpuric skin lesions. In purpura rheumatica the lesions have often seemed rather deeper in the skin and perhaps more sharply defined than the more superficial lesions of purpura hemorrhagica. Also the purpura rheumatica lesions often seem slightly elevated and are sometimes associated with urticaria and erythema, while the purpura hemorrhagica lesions are purely purpuric and are not elevated unless there is a large ecchymosis with a clot in the center. The differences between the lesions in these cases of purpura hemorrhagica (Case 2) and purpura rheumatica (Case 3) are difficult to describe, but I think that if you will compare the lesions in these two cases you will see that they have a different appearance.

The next and last case that I have to show you illustrates two points: (1) The early diagnosis of pernicious anemia, particularly from tongue symptoms—a condition originally described by William Hunter. (2) Symptomatic or secondary purpura hemorrhagica. I will present the case as it was two years ago and then show the patient to you as he is now.

CASE 4.—Two years ago the patient, a man forty-four years of age, came to the hospital for relief of "burning of his tongue and sore mouth." The following is the only history of importance that he gave: He had always been well except for scarlet fever and measles as a child, and acute appendicitis, with removal of that organ ten years ago. About one to two months ago he noticed that he was slightly more tired than usual, but did not feel sick. He feels but little more tired now than one month ago. During the past two weeks he has been constantly bothered with a sore mouth and tongue, particularly along the sides and tip of his tongue, a sensation described as "raw"; a "burning feeling"; "as if he had taken acid."

The physical examination showed a well-developed man, weighing 148 pounds, perhaps slightly pale, with clear scleræ. The tongue appeared smooth, moist and shiny, rather beefy in

appearance, and with a few very small herpetic-like lesions along the sides. The mucosa of the mouth was, in general, reddened. The teeth were in very fair condition, but there was some definite though slight pyorrhea. Except for this the physical examination was entirely negative.

The blood showed: Hemoglobin, 90 per cent. Red count, 3,900,000. The red cells appeared at a glance not abnormal, but when critically studied one noticed that there was a slight variation in size and shape, with a general tendency to larger rather than smaller red cells, while very rarely there was to be found a definitely enlarged oval-shaped red cell well filled with hemoglobin, and at times a very small red cell. The white count was 5000. Differential count showed 72 per cent. of polymorphonuclear neutrophils, 21 per cent. of lymphocytes, 7 per cent. of other cells. The platelets as estimated by brilliant cresyl blue smears were slightly diminished. Other laboratory tests yielded no particular information except that there was no free hydrochloric acid in the stomach contents. (Tests for blood destruction were not done.)

To look at this man, at that time, you would not perhaps have thought that he had pernicious anemia, but with the history, the blood findings, and the anacidity taken together, the diagnosis becomes clear and is proved by what followed.

All cases of pernicious anemia do not have the tongue symptoms that this patient presented. About 35 per cent. of the cases have this symptom at some time in the course of the disease, and it is usually an early rather than a late symptom, and, not infrequently, the earliest symptom. However, it is often not as intense as this patient described, and often does not cause enough inconvenience for the patient to seek relief. It is important to remember that this is a rather characteristic symptom of pernicious anemia, and cases presenting such a symptom should have their blood critically examined. Of course, you must bear in mind other causes of sore mouth and tongue, as dental ulcer, syphilis, cancer, tuberculosis, infectious stomatitis, at times simple pyrrohea, hyperacidity, etc. The onset of pernicious anemia is usually notoriously insidious. General weakness, as

this patient presented in a mild degree, gastro-intestinal symptoms, of which this tongue symptom is one, or symptoms referable to the central nervous system, are usually the way the disease first manifests itself. At present most cases of pernicious anemia are diagnosed months after the disease starts, notwithstanding that the patient has consulted a doctor. This is, I think, because the disease is not thought of until the patient begins to look pale or yellow. By bearing in mind that adults over thirty years of age presenting tongue symptoms may be cases of pernicious anemia some cases ought to be diagnosed sooner than they are.

It is noteworthy that this patient had an absence of free hydrochloric acid in the stomach contents, as this is the usual finding in cases of pernicious anemia.

The patient looked "perhaps slightly pale," but the blood examination showed a diminished red count with high hemoglobin, that is, the blood exhibited a high color-index, which is so characteristic of pernicious anemia. The finding of a few large abnormally shaped red cells with a few microcytes in the blood of a person with as high a hemoglobin and red count as this patient had is very suggestive of pernicious anemia, though this diagnosis should never be made *solely* on the blood. It is not necessary to find blasts to make the diagnosis. It is difficult in certain cases of pernicious anemia at the height of a remission, and hence presumably in certain cases very early in the disease, to recognize perhaps any definite abnormality of the red cells, but with a critical examination some abnormality is usually observed. The white count and platelets are usually low in pernicious anemia, but may not be reduced or but slightly reduced early in the disease or when the patient is at the height of a remission. We have felt that the number of platelets has furnished us with perhaps the best single laboratory finding to tell us the state the bone-marrow is in in this disease, and thus aid us to determine the patient's condition.

Having digressed to point out the tongue symptoms of pernicious anemia which this case presented so well, I will show

you the patient as he is today, exhibiting secondary or symptomatic purpura hemorrhagica.

CASE 4 (Continued).—The tongue symptoms subsided about two weeks after the patient was first seen two years ago. Then in the following three months he gradually failed in health and became much weaker, paler, and lemon-tinted. He also suffered from mild gastro-intestinal symptoms. Following this relapse he gradually improved, so that he felt quite well seventeen months ago, but not as strong as formerly. He remained in this condition until six months ago. During these past six months he has very gradually grown weaker and has had occasionally a sore mouth, more or less continually indefinite gastro-intestinal symptoms, with at times diarrhea, and has looked pale and slightly yellowish. Four days ago he began to have slight bleeding from his gums, which has persisted, and tiny red spots appeared on his lower legs yesterday.

Physical examination today shows a very pale, slightly yellowish man, with numerous fine petechiæ in the gums and mucosa of the lower lip. Blood may be seen oozing from about several teeth. (The pyorrhea has been treated since he was first seen.) There are a few small petechiæ scattered over the lower legs. Except for a functional systolic murmur and a palpable liver, and a pale, somewhat atrophied, shiny, and smooth tongue the physical examination is entirely negative.

The blood (certain details noted will not be mentioned): At the time he had his first relapse the red count was 1,500,000, and the hemoglobin 45 per cent., the blood showing all the features of primary pernicious anemia, including a leukopenia, diminution of platelets, and the presence of megaloblasts. Today the red count is 1,000,000, hemoglobin 35 per cent.; blasts are very rarely seen. The red cells show considerable variation in size and shape, and large oval and pear-shaped, deeply staining red cells occur. However, there is not as great a degree of variation in the size and shape of the red cells as occurred during the first relapse or as much as one might expect with this degree of anemia. This perhaps suggests an exhaustion of the marrow. Also the reticulated red cells are unusually low—but 0.3 per

cent.—which under the given circumstances also clearly suggests exhaustion of the marrow. One usually finds a slight increase of these cells in pernicious anemia, 2 or 3 per cent., and at times of rapid marrow activity they may reach as much as even 45 per cent., and often 10 per cent. The white count is 2000, and the differential count shows 65 per cent. of small lymphocytes, and but 30 per cent. of polymorphonuclears. Thus we find a marked absolute decrease of the white cells originating in the marrow, which further suggests a severely depressed activity or exhaustion of the marrow. The platelets are scant and number about 70,000, further suggesting a depressed or exhausted state of the marrow. The bleeding time is slightly prolonged, the coagulation time normal, and the clot retracts but very slightly. The development of the purpura hemorrhagica in this case of primary pernicious anemia illustrates an instance of secondary or symptomatic purpura hemorrhagica. What has occurred is that with the depressed or exhausted marrow activity the platelets have fallen so low that purpura hemorrhagica ensues. The marrow exhaustion is evidenced in the blood by not only one of the three formed elements, originating in the marrow, but by all. Pathologically the marrow of this patient would probably not show fatty degeneration (a soft yellow marrow) as occurs in idiopathic aplastic anemia, though this may be found as a terminal event in pernicious anemia. Probably in this case the marrow would be reddish and show an increase of erythrogenic tissue of abnormal character displacing and thus causing diminution of the megakaryocytes and normal leukoblastic tissue, though this latter tissue may be actually increased, but of an abnormal type. At all events the physiologic activity of the marrow becomes so weakened that it is unable to functionate to produce in the circulation more than a few of the normal elements. The development of purpura hemorrhagica in pernicious anemia, even though it be only manifested by a slight oozing of the gums, is a serious symptom. It rarely becomes marked, and by no manner of means do all cases of pernicious anemia have this symptom. It usually signifies that the disease has run its course and that a remission will not occur spontaneously nor can it be produced,

though the patient may continue to live for some weeks or months. However, a few cases may perhaps have this symptom and later have a fair remission.

There are numerous things about purpuras and hemorrhagic conditions as well as about the early symptoms of pernicious anemia that I have not told you about, but I have tried to point out some of the important things.

Treatment.—In regard to the special treatment of purpura hemorrhagica, whether it be primary or secondary, I will have time to say but a word. There is no special treatment unless the cases are having considerable hemorrhage, and then the best treatment is to give intravenously a suitable amount of whole blood from a donor of the same iso-agglutination group as that of the patient. This should be done as early as possible in the acute idiopathic cases. Unless the transfusion causes in some manner a permanent rise in the patient's platelets the cessation of hemorrhage will usually last about as long as the life of the transfused platelets, that is, about three to five days, though in some instances a rapid destruction of such platelets seems to occur, and the effect is then even shorter. Probably all the beneficial effect is not referable to the transfused platelets. A permanent or marked temporary rise of the platelets following transfusion in purpura hemorrhagica is referable to a stimulation, direct or indirect, of the patient's platelet-forming elements, or to a prevention of a destruction of the patient's platelets. Repeated transfusions are often without any lasting effect. In the instances where a toxin is recognized and removed, as in benzol poisoning, repeated transfusions are especially indicated so as to temporarily keep the patient from bleeding and to give the marrow time to regenerate and so recovery to occur. Serum at times may perhaps have some influence upon cases of purpura hemorrhagica, but is certainly not as effective as whole blood. Neither transfusion nor serums seem to have any particular influence on the purpuric skin lesions in purpura rheumatica, nor could we reasonably expect that they would, as in this condition there is no clear-cut recognized abnormality of the blood-coagulation mechanism.

The next best treatment to transfusion is the use of thromboplastic preparations derived from fresh tissue juice, perhaps combined with thrombin preparations. Tissue juice accelerates the coagulation of the blood markedly as well as do the platelets. This action of tissue juice has been recognized for years, but it has been but occasionally used for therapeutic purposes until recently. With Howell's discovery that certain extracts of the brain having the property of kephalin exert a marked thromboplastic action, it has been quite simple to obtain from animals stable, concentrated, and active preparations for local, subcutaneous, and intravenous use. The use of such substances is in the experimental stage, but seems to promise favorable results. Such preparations may be used before transfusion or when bleeding is slight, or they may be given trial at any time, but it is to be remembered that whole blood is at present the most logical and best therapeutic agent for the control of bleeding in pathologic hemorrhage.

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AMEBIC DYSENTERY AND ASSOCIATED CONDITIONS

General Consideration of the Amebæ Occurring in Man; Discussion of Varieties of Entamebæ; Discussion of Cases; Symptomatology; Diagnosis Based on Laboratory Evidence; Full Discussion of Treatment and Use of Emetine; Complications and Sequelæ; Differential Diagnosis; Bibliography.

October 27, 1917.

FOR consideration this morning we have two patients, one of whom is a typical and comparatively early case of amebic dysentery; the other presents symptoms which conform clinically to the picture of this same disease after the lapse of a number of years. In the first patient the diagnosis of his disease and its etiology are well understood; a specific treatment is available, and the prognosis is, comparatively speaking, extremely satisfactory. In the second case the primary etiologic factor is still undetermined and an accurate diagnosis has not been reached, although a thorough investigation has been made by clinical and laboratory methods. The condition is highly refractory to therapeutic measures and the prognosis is extremely unfavorable.

General Consideration of the Amebæ Occurring in Man.—In order to diagnose these cases it is necessary to understand thoroughly the amebæ which may be encountered in the alimentary tract in man. There are but three—the two parasitic entamebæ, namely, histolytica and coli, and the non-parasitic forms known as the limax group. The term "limax" includes a considerable number of species many of which have been only very incompletely described. They would be of no interest in clinical med-

THE AMEBÆ FOUND IN THE ALIMENTARY CANAL IN MAN

Variety of ameba.	Microscopic examination.	Morphology.		Cultural examination.	Parasitism in man.	Pathogenicity in man.	Transmission to lower animals.	Effect of emetine.
		Trophozoites.	Cysts (usual number of nuclei).					
E. histolytica.	Found in feces and in tissues of body.	Evidences of active motility, phagocytosis, pseudopodia of clear ectoplasm.	4	Negative.	+	+	+	Highly amebicidal.
E. coli.	Found in feces.	Homogeneous granular protoplasm very sluggish.	8	Negative.	+	o	+(?)	?
E. buccalis.	Found especially around the gums.	Small ameba tending toward histolytica type.	?	Negative.	+	o(?)	o	Amebicidal.
Limax Group.	Not demonstrable microscopically.	Variable according to species.	1 or 2	Easily cultivated.	o	o	o	Amebicidal *in vitro*.

icine except for the enormous confusion which they have caused in being mistaken for the pathogenic amebæ. They are not parasitic and cannot even multiply in the intestinal tract. Consequently they are not seen upon microscopic examination of the feces, but they can be demonstrated by cultural methods.

As regards even the principal characteristics of the amebæ found in man it must be noted that the literature is in an extremely unsatisfactory condition. Many contradictory opinions have been advanced concerning fundamental features, such as the number of pathogenic species occurring in the intestinal tract and the question of their cultivation on artificial media. In the last few years these opinions are gradually being harmonized. The data presented in the outline (p. 1126) conform to the generally accepted views of the best American and European authorities.

In this outline *Entameba tetragena* is not mentioned. It was described by Viereck in 1907 as a common cause of amebic dysentery in man and as a species distinct from *E. histolytica*. Careful descriptions were given of the characteristics of the trophozoites of the two species. The principal difference, however, was found in the propagative stage, *E. tetragena* producing four-nucleated cysts, whereas *E. histolytica*, according to Schaudinn, produces resistant forms by pinching off small pieces of protoplasm somewhat after the manner of budding in yeast cells. The establishment of this new species was soon recognized throughout the world. However, in 1911 Dr. Walker, formerly of Dr. Theobald Smith's department, decided that the normal manner of propagation in *E. histolytica* is not through a process of budding, but by the formation of a four-nucleated cyst. After careful study Walker finally concluded that *E. histolytica* and *E. tetragena* are identical. This apparently radical view was soon generally accepted throughout Europe and America, and the name *E. tetragena* has been dropped, *E. histolytica* having priority.

The attempts at cultivation of the entamebæ are full of interest. If a dysenteric stool rich in amebæ is inoculated on a medium containing only agar and water, an abundant growth

of amebæ frequently appears after one or two days. In general appearances the amebæ are not unlike those which were inoculated. Moreover, if this culture is inoculated in a monkey, amebic dysentery may occasionally be reproduced. On closer examination these amebæ have always proved to be of the limax group, having been ingested accidentally in the food and drink. Direct experimental evidence under carefully controlled conditions shows that they are non-pathogenic for man and lower animals and they cannot even colonize in the intestinal tract. The occasional production of dysentery by the inoculation of a freshly isolated culture may be accounted for by the mechanical carrying over of a few pathogenic cysts or perhaps by the spontaneous development of a natural infection of dysentery. The chief dissenters from this view are Musgrave and Williams. There is, of course, no inherent characteristic of the entamebæ which would prevent their cultivation. Indeed, there is every reason to believe that this will some day be satisfactorily accomplished.

The morphology of the amebæ has already been fully considered in your course in protozoölogy. Suffice it to say that in borderline cases the distinction beween the vegetative stages of coli and histolytica is an extremely difficult one. The study of the encysted stage is often disappointing. The cysts are frequently rare or absent altogether. There is no known way of making the trophozoites encyst *in vitro* or *in vivo*. Moreover, the number of nuclei is not absolutely fixed. Thus it is possible for cysts of *E. histolytica* to have two, four, six, or eight nuclei or even three, five, or seven. Similarly, *E. coli* may produce cysts containing four, eight, twelve, sixteen, or even more nuclei.

For the sake of completeness I have also included *E. buccalis* in this outline. Its position as a species cannot be fully determined till its propagative stage is known. I have indicated that it is non-pathogenic, though it may at times be one of the secondary factors in pyorrhea alveolaris.

Discussion of Cases.—In this first patient the essential features of his record are as follows:

CASE 1.—M. J., Hospital number 218,247, male, sixty-two years old, by occupation an artist.

Family History.—One sister died of tuberculosis at the age of twenty-five years; otherwise there is nothing important.

Past History.—This is essentially negative. The patient has never been robust and has always had "to take good care of himself."

Present Illness.—In May of this year—*i. e.*, about six months ago—the patient while in the West Indies had a sudden attack of diarrhea, passing three to five stools per day. Microscopic examination showed the presence of amebæ, and treatment with emetine instituted one month after the onset produced prompt relief, the patient remaining in relatively good health for about four months. Then a somewhat gradual onset of "diarrhea" occurred, culminating in a typical relapse. The patient does not know whether the stools contained any blood, as he did not notice their character.

Physical examination reveals nothing remarkable. The patient is not well nourished; there is moderate secondary anemia. The liver dulness is not increased and the edge is not palpable. There is no definite tenderness over the colon, and the sigmoid is not palpable.

Special Examinations.—A fresh specmen of stool shows a small amount of blood and several amebæ in both the motile and the encysted stage. Both stages show the usual characteristics of the pathogenic amebæ. In order to specify these organisms exactly they should be called *Entameba histolytica*, signifying a parasitic organism which dissolves tissues. The diagnosis of the disease is *amebic dysentery*. It is not necessary to use the term *entamebic dysentery*. A more precise designation would be *intestinal amebiasis;* this also has the advantage of conforming with such terminology as *filariasis* and *trypanosomiasis*.

Symptomatology.—In this one patient we have represented both the acute and the gradual types of onset. Many cases begin without any premonitory warnings recognized by the patient. Frequently, however, vague feelings of abdominal discomfort may be present for weeks or months, but they may not attract

the patient's attention. Examination of the stool at this period frequently reveals the true diagnosis. If untreated the infection may lie dormant for long periods before the acute attack develops or, less commonly, it may terminate in recovery.

The distinction between diarrhea and dysentery is one of considerable importance, and the terms are too often used indiscriminately. The information given by the patient is usually without value or even very misleading. It is a very common thing to be told that the movements contain no blood at all, but are very watery, though the first examination may reveal gross clots of fresh blood. Mistakes in the opposite direction are much less common. In this particular instance we are more fortunate; the patient admits that he does not know the character of his stools, never having noticed them. This is a very unusual answer.

If this case were allowed to go untreated the chances are that after some weeks of discomfort the symptoms would eventually subside and recovery would apparently have taken place. After a few weeks or months another relapse could be confidently expected. In taking the history of a case of dysentery it is extremely important to determine carefully whether there has been a succession of acute exacerbations followed by periods of remission or even constipation. Such a history is extremely suggestive of dysentery of the amebic type regardless of whether the remissions have occurred spontaneously or in response to emetine or any other form of therapy.

Clinically, there is but little to depend on for the differentiation of the bacillary and the amebic types of infection. The former tends to run a more acute course, the temperature being higher, and the patients look and feel very ill; in unfavorable cases evidences of peritonitis may appear. In the long-standing cases involvement of the liver, of course, indicates an amebic infection.

Evidence.—The ultimate diagnosis rests with the microscopic examination of the stools. The amebæ are not always abundant, since the early lesions are frequently situated high in the bowel in the cecum and ascending colon. In such cases a saline purge is

necessary to obtain suitable material for examination. The practice of passing a rectal tube or giving an enema is not to be recommended. Also the use of castor oil is inadvisable, since the many droplets of oil in the microscopic field causes momentary delay in the search for cysts. If a free purgation is obtained with magnesium sulphate, not only the first specimen but also the second and third should be carefully examined. It is of vital importance that only a few minutes should elapse before the examination is commenced. If some delay is unavoidable, the material may be kept either at room temperature or at 37° C. The organisms become more sluggish at the lower temperature, but they remain viable even longer than in the incubator. After a delay of three or four hours specimens frequently become quite useless.

Small flakes of blood or mucus should be selected, and if none are seen, shreds of mucus can often be obtained by whipping the stool with a platinum wire. It is often advised that the criterion of motility is essential in the identification of amebæ. However, it is entirely possible to recognize non-motile and pre-encysting forms with certainty. Indeed, if motility is required, diagnoses will frequently be missed even though the examination is made with an adequate warm stage; moreover, some of the pus cells may occasionally show slight ameboid motion.

After establishing the presence of amebæ it is theoretically necessary to identify the species and prove their pathogenicity. In an outspoken dysentery the amebæ if present are ordinarily characteristic of *E. histolytica*, and the final diagnosis is simple. Hypothetically it would be possible to have typical symptoms and only *E. coli* present in the stools. Fortunately this combination, if it occurs at all, is exceedingly rare. I have seen some moderately active cases whose stools contained amebæ which in their morphology tended more toward the coli than toward the histolytica type. These cases, however, responded promptly to emetine. Therefore when slight dysentery or even persistent diarrhea is present accompanied by amebæ in the stools, it would from a clinical standpoint be extremely unsafe to reject the diagnosis of amebic dysentery. There is another group of

cases in which the decision is more difficult; namely, when amebæ are found in the stools in the absence of any clinical symptoms, past or present. I know of one such instance in which after the examination of many specimens in the laboratory the amebæ were identified as *E. coli*. The patient was given a good prognosis and was not treated. A few months later a typical and fatal attack of dysentery developed. It is possible that the amebæ were incorrectly identified, for even the presence of an occasional eight-nucleated cyst does not absolutely establish the species as *E. coli*. On the other hand, in addition to the presence of *E. coli*, there may have been a latent infection of *E. histolytica*. Unfortunately, therefore, a perfect identification of species by a protozoölogist does not permit of a final clinical diagnosis. The establishment of the presence of *E. coli* does not exclude the possibility of the existence of a mixed infection.

In the case of liver involvement it is not an uncommon procedure to puncture a suspected abscess for the purpose of diagnosis. Pus from such abscesses usually does not contain amebæ, and bacteria are generally present. Even though the danger is slight, there is always the possibility of spreading the bacterial infection. After a surgical operation the pus which drains from these cases usually does not contain amebæ until several days have elapsed, *i. e.*, until the necrotic walls of the abscess begin to slough away. In the infectious diseases it would seem to be a fairly general law that the inciting organisms are found less frequently in the contents of a cavity and most abundantly in its walls, for this represents the site of the active process.

Therapy.—This morning we shall have time to consider only the specific measures. Intramuscular injections of emetine have replaced all previous forms of treatment. A soluble salt of emetine, such as the hydrochlorid, must be used. A good routine is to inject 1 grain morning and evening for one or two days, and continue with 1 grain in the evening for twelve to fourteen days. Then, after having discontinued treatment for two to four weeks, it is advisable, as a precautionary measure, to give a second course consisting of 1 grain intramuscularly per day for two weeks. This second course of emetine could hardly be as

effective as the treatment of a relapse, since amebæ in the encysted stage are probably not injured by therapeutic doses of emetine. The immediate relief of symptoms is so prompt and so complete that it is seldom necessary to employ subsidiary measures, such as the use of Dover's powder. Usually after about two days the stools will be semiformed or even formed, the blood will have disappeared almost completely, though a few amebæ may still persist. Although the immediate response is so excellent, it is almost the rule in these cases that a typical relapse will occur after a few months or even years. I have in mind one patient, a native of Massachusetts, who contracted the disease in Central America. He was treated energetically with emetine and apparently cured, remaining perfectly free from symptoms for three years. Then, without having revisited the tropics and without being re-exposed to infection in any known way, a perfectly typical relapse developed. This yielded promptly to emetine, only to be succeeded after three months by another relapse. This seems discouraging. However, if each relapse is promptly and thoroughly treated these patients will eventually recover.

This general routine for the use of emetine can only be applied in the ordinary typical attack. There are two groups of amebic cases in which emetine is almost without action—namely, (1) the extremely acute, and (2) the extremely chronic types. In fulminating infections the use of as much as 2 grains of emetine intravenously at one injection frequently fails to control the symptoms, and the patients go on to a rapidly fatal termination. It is probable that death in these cases is due to a secondary bacteremia, though the proof for this view is not yet complete. Indeed, like the other protozoa and in contrast to many of the pathogenic bacteria, it is not known in what way the entamebæ produce their harmful effects. It may be seriously questioned whether *E. histolytica per se* is able to produce a fatal disease in man; in the majority of instances the fatal termination is apparently effected only by the aid of secondary bacterial infection.

No explanation is at hand for the failure of emetine in the

extremely chronic cases. I have studied several such cases with Dr. Baetjer in Baltimore. They were characterized by a watery diarrhea with only the occasional appearance of traces of blood and mucus. From the morphology alone the pathogenicity of the amebæ found in the stools might well have been seriously questioned; their etiologic rôle, however, was proved by animal experimentation. So you must not allow the failure of emetine in chronic cases to deter you from a final diagnosis of amebic infection.

The history of the development of therapy with ipecac and emetine has been an interesting one. The crude drug had long enjoyed considerable popularity with the natives of India. These clinical results attracted but little attention in the western world. The drug was still further discredited by apparently careful work, which seemingly proved that any virtue which it possessed was at least not due to its content in emetine. Equally good results were obtained when de-emetinized preparations were substituted for the crude drug. It was hoped that this apparently reliable discovery would greatly increase the use of ipecac since the successful administration of emetine by mouth is an extremely tedious process. However, both the crude ipecac and the de-emetinized preparations fell into disuse. Vedder in 1910 showed that emetine was highly amebicidal *in vitro* for cultural amebæ, and a little later Rogers introduced the use of the alkaloid in India. Recently the use of emetine has supplanted not only the crude ipecac but also the custom of giving cleansing irrigations—in the ordinary cases rectal irrigations of saline or of highly diluted solutions of quinine are no longer employed.

There are certain precautions which should be observed in the use of emetine. It has been reported that untoward effects sometimes appear shortly after the first injections of the drug. The initial symptoms which have been described are hyperesthesia, paresthesia, and other disturbances of sensation, especially of the lower extremities. If these appear, the injections should be discontinued for a time at least. Such symptoms may be due to an unusual susceptibility or to the unexplained appearance of toxic properties in apparently standard preparations of emetine.

The latter feature has been emphasized in the literature, but, unfortunately, sufficient care has not always been exercised in distinguishing between the supposedly toxic properties of emetine and some of the less common manifestations of the amebic infection itself.

There is another point of considerable practical importance concerning the injections. The drug is rather irritating and not only routine but even expert care in asepsis must be exercised if secondary infection is to be always avoided. The injections should be given intramuscularly, and they should not be repeated in the same location until a period of several days or a week has elapsed.

One other drug should be mentioned, for it may possibly prove to be as good or possibly better than emetine. This is a small shrub growing in northern Mexico and Texas. Botanically it is one of the simarubaceæ; locally it is known as chapparo amargoso, a Mexican designation signifying "bitter bush." It has been used for decades by the Mexicans with such good results that it has been adopted for routine use by some of the American practitioners in Texas. The best accounts have been reported by Nixon. An infusion about the color of weak tea is prepared with boiling water from the dried stems and leaves of the plant. This is apparently non-toxic for man and is administered in liberal quantities by mouth and by rectal injection. The immediate results are as good as with emetine and the relapses are much less common.

Our rather limited experience here in the North with this plant has been encouraging in the typical cases. In two of these the immediate response was very good. A third case was particularly interesting. This patient after receiving injections of emetine for two weeks still had dysentery with motile amebæ in the stools. He yielded promptly to treatment with chapparo. Clinical evidence, even though very encouraging, can be notoriously misleading. Recently some additional information concerning this plant has been obtained by Dr. McIver and myself.[1] We have secured concentrated aqueous extracts which proved to

[1] Publication in press.

be highly toxic for small animals. A feasible method was devised for isolating this toxic principle in relatively pure form. Chemically the reactions of this purified product are interesting; it gives a fair precipitate with some of the more general alkaloidal reagents; with sulfuric acid a striking color reaction is produced, and after boiling with hydrochloric acid it reduces Fehling's solution. This product is amebicidal *in vitro*. Two cases of amebic dysentery yielded promptly to small doses of this product administered by mouth. It is needless to say that its ultimate value can only be determined by the observation of a large series of cases over a period of several years.

Complications and Sequelæ.—One can with reasonable confidence expect to avoid complications or sequelæ in amebic infections under proper treatment. Indeed, after definite signs of liver abscess have already developed complete relief can sometimes be obtained by emetine therapy without resort to surgical interference. Metastatic abscesses from the intestines by way of the blood-stream naturally localize first in the liver. The right lobe being larger than the left, a proportionally large number occur on the right side. They may be single or multiple and occasionally they are surgically inoperable. Not infrequently in a patient with definite clinical signs of liver abscess nothing will be found on exploration. It is quite possible to overlook these abscesses surgically; the lesion may be very small and situated high up in the dome of the liver, or it may be a larger mass of necrotic tissue containing no free fluid. In such cases it is important to examine any tissue obtained in the lumen of the aspirating needle.

A liver abscess may rupture into any of the adjacent structures, such as the lung, so that the diagnosis has been made from the resulting sputum that is coughed up. Exceptionally, as a curiosity, the primary abscess may appear in other organs of the body, such as the brain or the spleen.

In considering the pathogenicity of the amebæ a remarkable feature has been pointed out by Dr. Edsall, namely, that although relapses are extremely common in the intestinal infections, they are rare indeed in the cases of liver abscess. This was true of

the hepatic infections even before the introduction of emetine. Once a case has been explored surgically and recovery has taken place then relapses seldom, if ever, occur.

The cases of amebic infection will not always conform to simple well-recognized types. A few years ago a boy of about fourteen years came to the hospital presenting anatomically a typical picture of Hirschsprung's disease. Examination of the stools showed the presence of pathogenic amebæ, and upon inquiring more carefully into the history it developed that there had been a chronic dysentery of many years' standing. At operation a fibrous band was found just above the sigmoid. The healing of the lesions in the submucosa of the intestine had led to excessive scar formation and the development of a moderate grade of stricture.

A rare and extremely unfortunate occurrence is the development of a polyarthritis after amebic dysentery. Its origin is unknown; possibly it results from a secondary bacterial invasion of the blood-stream.

Like many other protozoan diseases, the carrier stage is a well-recognized condition, and is one of the important ways in which the infection is propagated. I have seen one individual who had always been free from symptoms but whose stools usually contained an abundance of four-nucleated cysts; these were proved to be pathogenic for animals. In contrast to these quiescent cases there is another very different type of long-standing infection, namely, chronic amebic dysentery. Some of the late cases could very properly be regarded as illustrations of the sequelæ of the disease; in many of these patients it eventually becomes difficult or impossible to demonstrate amebæ, and the essential lesion is an extensive involvement of the colon by pyogenic bacteria.

We have such a case here in the wards now. This man, fifty-two years old, was formerly a fisherman in Nova Scotia. He has been in Massachusetts two years. Two months ago he was admitted to the emergency ward in almost complete collapse with an increase in pulse, respiration, and temperature (pulse, 100; respirations, 25; temperature, 100° F.). Apparently he

had lost considerable blood by hemorrhage from the rectum. He was incontinent and was passing small quantities of blood and pus more or less continuously. Some days later the following notes were obtained:

Family History.—There has been considerable exposure to tuberculosis, the mother and one sister having died of this disease.

Past History.—The patient says that he has a cough every winter and that he had one hemoptysis five years ago, spitting up a tablespoonful of blood. Otherwise the past history is negative, though rather indefinite and unsatisfactory.

Present Illness.—For the past nineteen summers the patient says he has had attacks of "diarrhea" similar to the present one. This one seems to have come on without much warning.

Physical Examination.—There is some spasm and some tenderness over the transverse colon. The liver dulness is not increased, the edge is not palpable, and there is no tenderness along the costal margin.

Special Examinations.—The blood showed on admission a slight secondary anemia. The white count was 27,000, showing a polymorphonuclear increase. The Wassermann reaction was negative. Dr. Taylor found that the patient's serum agglutinated a culture of the Strong variety of bacillary dysentery at a dilution of 1 : 50. The stools were composed of blood and pus with virtually no fecal matter. No animal parasites were found; no amebæ were seen either in the motile or encysted stage. Examinations for tubercle bacilli were negative. Cultures for the organisms of bacillary dysentery were negative. Practically complete absence of the colon bacillus from the stools was noted.

Differential Diagnosis.—In this patient we can pass at once from the non-infectious diarrheas and proceed to the infectious diseases. We must consider not only the two specific dysenteries but also all of the other conditions which may simulate these two diseases. Especial attention should be directed to syphilis, to tuberculosis, and to malignancy of the large bowel. You will not, of course, overlook the possibility of hemorrhoids. The

symptoms in this man have been much more acute than are characteristic of syphilitic proctitis. The history directs attention to tuberculosis, but the general and special examinations show no evidence of active tuberculosis anywhere in the intestines or in any other part of the body. Malignancy is an extremely important consideration, and the differentiation from dysentery is not easy. I have seen mistakes made in both directions, and these happened after the cases had been carefully studied. One patient with a moderately large mass over the descending colon was regarded for some time as an amebic infection. The condition was eventually proved to be a carcinoma. Another case of intermittent dysentery eventually came to operation. The stools had been free from amebæ and at exploration the diagnosis of diffuse carcinomatosis was made. A section of the bowel was removed and amebæ were demonstrated in the submucosa.

In this patient I think we can with reasonable safety exclude syphilis, tuberculosis, and malignancy. While these conditions may simulate a short attack of typical dysentery, it is only the amebic and bacillary infections that can produce severe, sustained symptoms extending over months and years; however, in their atypical forms either of these varieties may simulate perfectly the usual course, for example, of tuberculosis of the intestine. In this patient it is now impossible to determine whether the disease in its origin some years ago was a bacillary or amebic infection. The agglutination tests are somewhat suggestive, but unfortunately these tests as well as the cultural procedures have never been fully developed for use in chronic colitis. In order to explain these dysenteries it is not necessary to postulate a new specific etiologic agent. There is considerable evidence that both amebic and bacillary dysentery are endemic in New England. Indeed, acute bacillary infections occur with considerable frequency in children in the summer months. On the other hand, it does not necessarily follow that these cases will conform to the known types; it is quite possible that still another specific agent of dysentery may be found. The ultimate solution of the problem would be greatly facili-

tated by the application of cultural methods based on the new principles that have recently been developed by Dr. Teague in the isolation of the typhoid bacillus from the stool.

The treatment of these neglected cases is very unsatisfactory. Even if amebæ could be demonstrated, virtually no benefit could be expected from emetine. Consequently, its administration on general principles is not indicated. Similarly, it is too late for the use of the various specific sera that have been proposed for the treatment of bacillary infections. One must resort to general measures, giving attention to the comfort of the patient, the diet, the minor measures for the control of hemorrhage; fluid must be restored, if necessary, by the injections of salt solution or by the transfusion of blood. The intestinal discomfort can be relieved symptomatically by the use of bismuth or opium. Surgical interference has been practised lately in many of these cases. Ordinarily an appendicostomy is done to facilitate the irrigation of the large bowel. It is permissible to use with care mild cleansing solutions, such as normal saline solution or highly diluted quinine (1 : 5000). The irritating solutions have never come into general use, and in my opinion they should be carefully avoided. In advanced cases the results of operation are too often discouraging.

Recenty some success seems to have been obtained by performing an ileostomy. By means of this artificial anus the large bowel is put to rest and its irrigation is facilitated. The operation together with the resulting rapid passage of the intestinal contents through the small bowel constitutes a considerable tax on the individual's strength. The surgeons feel that frequently interference is delayed too long and that it is employed only as a last resort in subjects already much emaciated. In moderately early cases medical measures should first be given a thorough trial; if the symptoms do not yield after a reasonable interval, then surgical procedures should be seriously considered.

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CLINIC OF DR. JAMES B. AYER

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FOCAL TRANSVERSE LESIONS OF THE SPINAL CORD

Definition. Importance of Early Recognition of Etiologic Factor on Account of Great Variety of Treatment. Possibility of Making Such Diagnosis Should be Possible in Most Cases by Elimination and Proper Employment of Modern Methods in Diagnosis, Particularly Examination of the Spinal Fluid.

IT is often easy, but frequently difficult, to diagnosticate a focal transverse lesion of the spinal cord. The importance of making a correct and early diagnosis in such a condition is great, because the treatment is so various.

What is meant by the term "focal transverse lesion of the spinal cord"? Simply speaking, any affection which, acting at a given level of the cord, prevents or impairs the passage of nerve impulses above and below this segment. Why, you will say, is not the time-honored term "transverse myelitis" employed, for that is obviously what you mean? Because the term "myelitis" is a poor one, connoting inflammation, and most of the lesions with which we are here concerned are non-inflammatory. While the initiated may use this short expressive term without risk, there is, as I have found, danger of misguidance from the employment of "transverse myelitis" when applied to tumors, hemorrhage, and fractures, all of which are frequent factors in the symptomatology of focal lesions of the spinal cord.

As has been said, many focal cord lesions are easy of diagnosis, as, for example, the considerable group of fractured spine. Of those diagnosticated with difficulty, the chief stumbling-blocks

are the tract or system diseases, certain disseminated cord lesions, and affections of the peripheral nervous system.

What, then, are the characteristics by which a transverse lesion of the cord may be recognized, and what the differentiating points from conditions which simulate it? Typically, a focal transverse lesion, if not too sudden in origin nor too complete in its effects, will show (*e. g.*, a tumor pressing upon the middorsal cord) ataxia and spasticity of legs, together with diminished cutaneous sensibility up to the affected level, in this case the ensiform cartilage. Above this level there will be a band of hyperesthesia 2 to 4 cm. in width. Above this, motor and sensory functions intact. To this picture may be added in many cases pain affecting the sensory nerve-roots of the level affected, and rarely atrophy of muscles supplied by the motor nerves of this same segment. If under observation for some time, we usually find an increase in severity of the above symptoms, but do not expect evidence of much vertical extension of the process.

In what manner does a *tract* or *system disease* differ from this description? Syphilitic ataxic paraplegia, combined system disease, and, rarely, tabes may be mistaken for focal disorder of the cord. In all the presence of a well-marked level of sensory change and localized root pain (confined to a given level) are absent; and in the two latter observation over a period of time will show unmistakable signs of involvement of the cord at more than one level.

Disseminated lesions of the cord are usually manifest by their multiple foci. Nevertheless the lesions of multiple sclerosis and syringomyelia may be so much more marked in a given segment that the other lesions of the cord and even brain may be overlooked. Even on the advice of careful neurologists operation for supposed cord tumor has frequently been performed in such diseases.

Diseases of the peripheral nervous system are not infrequently confused with cord lesions, but this statement applies more to the tract than to focal disorders. In these cases we do find sensory changes, but even superficial examination reveals a diminishing

anesthesia from periphery to center, and fails to show a proper sensory level; moreover, spasticity is absent.

It is then a comparatively easy matter to separate the typical focal cord lesions from other lesions. Difficulty arises when we are concerned with the atypical of either group. Not less in importance and no easier is the recognition of the several causes and pathologic states within the group of focal lesions.

Before we consider cases it will be best to speak of *accessory aids to diagnosis* which are now available. From examination of the blood we may derive knowledge of some benefit. A leukocytosis will suggest infection, and perhaps lead to detection of abscess, as in two of our cases. Pernicious anemia may be detected and thereby throw the evidence of a questionable case in favor of combined system disease. A positive blood Wassermann must be explained, but with the reiterated warning of the argument that because (1) the patient has spinal cord trouble, and (2) the patient has a positive Wassermann, *ergo*, the patient must have syphilis of the spinal cord. From the urine less is to be learned than in many disorders. The occurrence of Bence-Jones bodies, however, should be noted in connection with myeloma of the vertebræ.

Of greater value than the above is the *x*-ray. The field of the *x*-ray is here limited—from the diagnostic point of view—to affections of the vertebræ; only by inference can we estimate the effect of fracture, dislocation, or disease of the vertebræ upon the spinal cord.

By far the most important laboratory aid is that presented by the examination of the spinal fluid. The greater number of focal cord lesions are produced by pressure exerted from within or without the cord; this results, as Mestrezat[1] first pointed out, in the formation of a culdesac below the point of compression and a dilatation of the blood-vessels at the point of pressure. Therefore on withdrawal of spinal fluid from below we find it under low pressure and very rich in albumin and frequently of a clear yellow color. Moreover, this lemon-colored fluid quickly clots. Cells are absent or few in number and cultures are negative. The

[1] Mestrezat: Liquide céphalo-rachidien normal et pathologique, Paris, 1912.

low pressure is best explained by the shutting off of this culdesac from the spinal fluid column above the compression, spinal fluid pressure corresponding chiefly to the venous pressure in the brain; owing to dilatation of veins (usually visible at operations on such cases) transudation into this area of low pressure readily takes place, giving a high albumin content and allowing thrombin and thrombinogen also to pass, along with coloring-matter, presumably from decomposed red blood-cells. The usual absence of cells and constant absence of bacteria signify that the formation of this fluid, characteristic of cord compression, is not of inflammatory origin.

As variations of this "syndrome of Froin"[1] we find at times that there is an increase of inflammatory cells, usually lymphocytes, signifying that besides the compression there is inflammation present. At other times the pressure is not low. But the most important variation gives us a fluid which superficially seems to have no relation to the "complete syndrome" as given. Where presumably the pressure upon the cord has been insufficient to shut off the spinal fluid column, we find a fluid of normal appearance, colorless, under normal pressure, but one which contains an abundance of albumin. This fluid does not clot, it may or may not contain cells. Such a fluid falls into the group of "Nonne's incomplete syndrome."[2] The significance of both fluids is the same—*i. e.*, compression of the cord.

Unfortunately, the spinal fluid findings do not tell us where or what the lesion is, though it is noticeable that the more complete the compression and the more rapidly it has been produced, and also the further down the cord the compression exists, in these cases the complete syndrome is more likely to occur.[3]

Unfortunately, also, the findings are not always characteristic of cord compression where such exists; but the existence of the incomplete syndrome is evidence in favor of it; the presence of the complete syndrome is perhaps as nearly pathognomonic as any single sign in medicine.

[1] Froin: Gaz. des Hôp., 1903, lxxvi, 1005.
[2] Nonne: Deutsch. Ztsch. f. Nerven., 1910, xl, 161.
[3] Ayer and Viets: Jour. Amer. Med. Assoc., 1916, lxvii, 1707.

Let me now place before you a list containing at least all the common, and some unusual, types of focal cord disorder. The following classification alone, giving conditions only which are known to me personally, gives a good idea of the great variety of pathologic agents at work and of the manner in which the spinal cord may be attacked at a given level, presenting the clinical picture of "transverse myelitis."

Intramedullary affections:

Hemorrhage.
Myelitis—infectious or toxic.
"Myelitis"—vascular thrombotic.
Tumor—glioma.
Syringomyelia—gliosis spinalis.
Dermoid cysts and growths from ependyma of central canal.
Solitary tubercle.

Meningeal:

Chronic meningitis (more often meningomyelitis), syphilitic, cervical, hyperplastic (syphilitic).
Varicose veins.
Tumor:
Fibroma.
Glioma by extension from brain.

Extrameningeal:

Disease of vertebræ:
Tuberculosis.
Tumor—especially myeloma.
Metastatic.
Osteomyelitis with epidural abscess.
Charcot spine.
Fracture of vertebræ.
Dislocation of vertebræ.
Abscess—epidural—not from vertebra.
Aneurysm, eroding.

FOCAL CORD AFFECTIONS—CLINICAL RÉSUMÉ

Onset.	*Etiology.*	*Progress of Symptoms.*	*Pathologic Condition.*	*Aids in Diagnosis.*	*Treatment.*
Sudden.	Trauma.	Symptoms of focal affections complete, tending to improve.	1. Intramedullary hemorrhage. 2. Fracture of vertebra. 3. Dislocation (1 may occur alone. More often all three are present). 4. Fracture of a diseased vertebra.	History of accident in 1, 2, 3. *x*-Ray should differentiate fracture, dislocation, and disease.	Expectant at first. Later orthopedic, and at times operative.
Rapid.	Acute infections.	Symptoms of obscure cord affection progressing rapidly, assuming a focal character and frequently resulting in complete transverse myelitis.	1. Myelitis, usually toxic; disintegration of cord focally. 2. Epidural abscess.	Patient shows evidence of bodily infection and focus of which may or may not be evident. *x*-Ray negative as a rule. Spinal fluid in (1) apt to be negative; in (2) shows the complete compression syndrome. Both bacteria free.	1. Expectant. 2. Operative.
Slow.	Chronic infections. Tumor. (Vascular.)	Symptoms of slowly increasing pressure on cord at a given level.	1. Chronic syphilitic meningitis or meningomyelitis. 2. Tuberculosis of vertebra. 3. Charcot spine. Gumma spine. 4. Tumor of vertebra (usually metastatic). 5. Tumor of meninges. 6. Intramedullary tumors.	1 and 2 show other evidence of syphilis of C. N. S. Blood and spinal fluid tests usually positive in (1); negative in (3). *x*-Ray should show characteristic picture of (2), (3), and (4). All will usually show spinal fluid compression syndrome, for most part "incomplete," but some the "complete" syndrome.	1 and 3 antisyphilitic treatment if the tests are positive for active syphilis; 2 and 3 orthopedic; 4, symptomatic; 5 and 6, operative.

Of far more value to us as clinicians is the accompanying classification, which I have prepared in the briefest and most dogmatic form, omitting exceptions to the general rule and pathologic subheadings for the sake of clearness. With this table before you, it will be observed that most focal cord affections may be placed in three general groups, according to whether the onset be sudden, rapid, or slow. It is further noticeable that the agents at work in the first two groups are two—trauma and acute infection; if we exclude the traumatic cases with sudden cord lesions and the acute infections, cases with rapidly progressive lesions, we have already eliminated a very considerable number of causes of focal cord affections. We then turn to the third and by far the most heterogeneous group —lesions of slow onset and progress—due usually to chronic infections and to tumors.

Fig. 181.—Fracture-dislocation of dorsal spine with complete disintegration of cord at this level. (Case of Dr. E. W. Taylor.)

GROUP I.—LESIONS OF SUDDEN ONSET

Here are included the very considerable number of cases of "broken back" and "broken neck," ordinarily described in text-books under "Injuries to the Cord." The diagnosis is usually obvious. There has been an accident, perhaps a heavy weight has fallen on the spine, or the body has been suddenly bent into an awkward position, "something cracks," and the result is a complete paralysis below the point of fracture or dislocation. A not infrequent cause is a dive into shallow water with sudden wrenching of the neck.

CASE I.—The accompanying photograph (Fig. 181) shows well a wedge-like protrusion of a dorsal vertebra, accompanied by fracture, which has completely severed the cord, although the dura is still intact; the accident was in a boy who was thrown over backward, striking the back of his head and neck. Needless to say there was immediate paralysis of legs and lower part of body with total loss of sensation and sphincter control. Bed-sores developed and death ensued after a few months.

Fig. 182.—Bilateral dislocation of seventh cervical vertebra on sixth cervical. From falling from wagon.

CASE II.—Mr. A. M., fifty years of age, fell from a wagon and struck on the left side of his head. He was unable to move his legs and his arms were almost completely paralyzed; there was complete anesthesia extending to level of third intercostal space; above, zone of hyperesthesia. Deep reflexes absent. In this case (Fig. 182) *x*-ray shows a bilateral dislocation of the

seventh cervical vertebra on the sixth, with little evidence of fracture. Attempt at bloodless reduction was only partially successful and open reduction was resorted to, with good operative result (Fig. 183); the trauma to the cord had been so extensive, however, that little change resulted from the operation.

Hematomyelia, without fracture or dislocation or of insignificant extent, is of frequent occurrence. In such cases the clinical

Fig. 183.—Same case as Fig. 182. Open reduction and wiring. No improvement in spinal cord symptoms of complete transverse lesion.

picture soon after the accident may be that of transection of the cord, but with absorption of the hemorrhage and edema impulses may soon begin to pass along the cord, and the ultimate amount of destruction may not be great. As the hemorrhage tends to confine itself to the gray matter of the cord the long projection fibers are frequently spared in such cases, and the resultant paralysis tends to be referred to the cells of the segment or segments in

which the hemorrhage has occurred. Figure 184 represents a severe hematomyelia without vertebral fracture or dislocation. Such cases are to be treated expectantly.

At times we meet with patients who have an alternating paralysis following trauma. In one position the patient will be paralyzed, in another he can use his limbs; here we must admit a physiologic shutting off of nerve impulses from recurring transitory pressure. Fixation or operation are here imperative.

"Compression fracture" results from blows received and transmitted vertically rather than from the side or the back. In these the *x*-ray shows the bodies of the vertebræ fused and

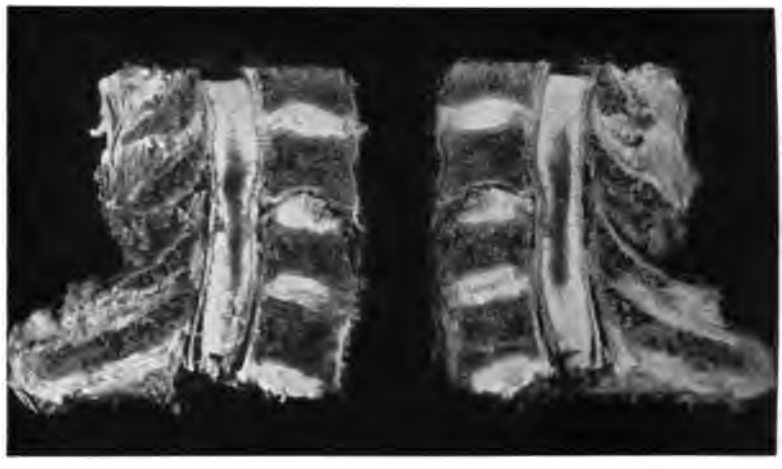

Fig. 184.—Hematomyelia from trauma. Little or no evidence of fracture.

laterally displaced, but the symptoms are rather of nerve-root origin, the cord usually escaping injury.

In this group we must also consider cord injuries received from fracture or dislocation of diseased vertebræ with sudden effects. As a rule, however, unless there is the additional element of trauma, the diseased vertebra exerts its influence by slow compression of the cord, and more properly should be classed in Group III. Nevertheless spontaneous fracture of a diseased vertebra may take place, with resultant sudden injury.

In this group, then, we include hemorrhage into cord, laceration of cord, and pressure upon cord as result of trauma. Unless

completely severed or severely damaged the tendency is to improvement. Treatment is, for the most part, of an orthopedic nature; rarely does open surgery do more than can be done with the properly applied brace. On this point, however, there is

Fig. 185.—Dislocation and fracture of cervical vertebra from trauma. In this case there was injury to motor and sensory nerve roots, but *no affection of the spinal cord*. The extent of trauma as indicated by *x*-ray is no criterion as to the extent of injury to the spinal cord.

difference of opinion, a number of writers on cord surgery in the present war advocating strongly more frequent laminectomy at the earliest possible moment in traumatic spinal cord conditions.

GROUP II.—LESIONS OF RAPID ONSET

Although "transverse myelitis" is the term colloquially used in describing the various conditions under consideration, it is rarely that a pathologic picture answering to this condition is seen. True, we not infrequently make such a diagnosis clinically; a patient with some infection, notably pneumonia, develops a rapidly progressive transverse lesion of the cord, and at death a disintegration of the cord substance is found. Organisms are not demonstrable, and the condition is put down as toxic in origin, although small vascular thrombi are said to play a part. Usually

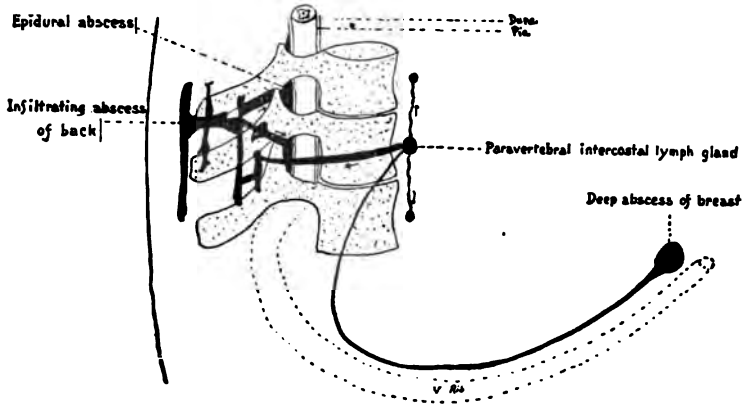

Fig. 186.—Diagram to show course of infection from deep breast abscess by intercostal lymphatic to lymph-node; thence by direct extension to back muscles and epidural space.

the process is severe, but improvement may occur to a considerable extent if the patient live. I have never seen this picture of toxic transverse myelitis from bodily infection, though I have several times made such a diagnosis in the living. Two cases, however, presented this pathologic condition in the medulla, in one case associated with a large chronic liver abscess.

The picture of toxic myelitis was produced in the case of a man presenting an epidural abscess which subjected the cord both to pressure and toxic influences. Although a rare condition, yet because of its importance from the therapeutic point of view and because the clinicopathologic data may here be traced

so clearly, it will be well to present the case in full, with abstract from a published article[1] (Fig. 186):

O. J., forty-three years, on August 20, 1915, while roofing a house, scratched his right breast on a nail; from this an abscess developed, and on September 3d broke, yielding subsequently to surgical treatment. About September 11th, however, the patient complained of "pleurisy pains" in left back and later also in left lower chest, which persisted, accompanied by a temperature of 102–104° F. On September 26th he could not pass urine for the first time, and complained of pains in legs as well as back. His back was rigid and tender over the seventh and eighth dorsal spines. The next day he had difficulty moving his legs, and by September 29th he was paraplegic, with urinary and fecal incontinence. Neurologic examination showed, besides the almost complete paralysis of legs, a mild bilateral sensory disturbance below umbilicus; knee-jerk present, ankle-jerk not obtained, plantars normal, abdominal and cremasteric reflexes absent. Head and arms not remarkable. Examination of the back showed some fulness only in dorsal region and crackling râles at bases of lungs. Lumbar puncture gave 4 c.c. only of clear yellow fluid, under no excess of pressure; the fluid clotting almost immediately. In twelve hours the fluid separated spontaneously from the clot and was found to give a negative Wassermann, a gold sol in the "meningitis" zone, great excess of proteins, and to be sterile on culture; the clot was macerated, and examined for cells, one only being found.

In seven days the patient died.

Abstract of Autopsy (five hours postmortem): Just to the right and below right nipple is an area, 10 cm. in diameter, of granulation tissue; from it no pus can be expressed, nor is there any in the surrounding tissue. The first incision into the back, however, yields a thick greenish pus; investigating deeper and more extensively shows that this pus has infiltrated the trapezius, latissimus dorsi, and erector spinæ groups of muscles. Dissecting to the spinal column, pus is seen to well up between the vertebræ, and when the laminæ and spines have been removed, a thick coating

[1] Ayer and Viets: Boston Med. and Surg. Jour., clxxv, p. 865, 1916.

of pus hides the dura from view for a distance of 10 cm., corresponding to the fifth, sixth, and seventh dorsal vertebræ. The pus is easily stripped from its position on dura and from the nerve-roots which it surrounds, leaving the former perfectly normal in appearance. The dura opened reveals a glistening inner surface and a cord of normal appearance, but the spinal fluid in the lumbar sac is of yellow color and, as analysis shows, is similar to that withdrawn previously. Even on section the cord presents everywhere normal appearance and markings.

Turning now to the pleural cavities: both contain a small amount of serofibrinous fluid and a few fibrinous adhesions, especially posteriorly on the right. On cutting through the pleura at this region pus exudes, and search shows that it comes from two sources, the erector spinæ muscles and necrotic paravertebral intercostal lymph-glands, the latter being affected more particularly in the neighborhood of the fifth dorsal vertebra.

Other postmortem findings are inconsequential. Cultures: pus from the back muscle; pericardial fluid and fluid from right pleural cavity—Staphylococcus albus in pure culture. Heart's blood, no growth.

Microscopic examination was carried out in routine manner on the tissues of the body, without striking addition to the gross findings. Microscopic examination of the spinal cord is, however, of considerable interest and importance, and is here given. First to be noted is that there is no distortion of the cord in the region of pressure and the size of the cord is not diminished; in fact, sections at one level suggest an actual, though slight, enlargement of the cord, fibers being separated more than normal, with presence of vacuoles, the cord at this point to the naked eye giving a moth-eaten appearance. While there is no certain destruction of nerve-fibers, such degeneration is suggested by the presence of a few phagocytic cells in the rarefied areas of the white matter (Fig. 187). Throughout the white also, but more particularly near the rim of the cord, a moderate increase in number and size of neuroglia cells is seen, some with faintly staining protoplasm; no evident increase of glia fibrils is to be seen. The gray matter pre-

sents normal configuration; the anterior horn cells are present in correct number, but many present the axonal reaction. Vessels appear normal and there is no evidence of dilatation or cellular infiltration of perivascular spaces. The pia is of particular interest because of its proximity to the abscess, which is separated from it only by dura. The pia shows a slight cellular infiltration, and on close examination the cells are found to be largely fibroblasts

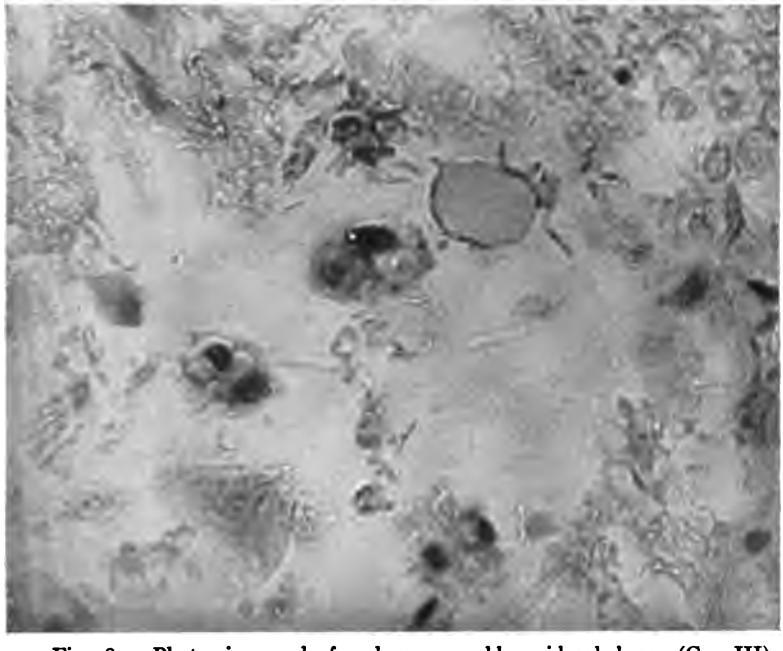

Fig. 187.—Photomicrograph of cord compressed by epidural abscess (Case III). Shows degeneration of nerve-fibers in white matter with phagocytosis—a condition of "compression-toxic-myelitis." The spinal fluid was free from bacteria.

with a few plasma cells and lymphocytes; no polynuclear leukocytes are seen in the pia. Nerve-roots, both dorsal and ventral, show perhaps a slight increase in fibroblasts, but no evidence of exudative cells.

It would take too long to go into the interesting possibilities of toxic degeneration of the cord from infections at a distance or by extension along nerve-roots. By far the most important contributions on this subject have come from Orr and

Rowes and their collaborators,[1] whose articles are of a most stimulating character.

GROUP III.—LESIONS OF SLOW ONSET

In dealing with the third group we find that we are concerned with an actually greater number of cases, of more various etiology, and also of more wide-spread manifestation—hence a more difficult problem. And yet in this group it is fully as important that an accurate diagnosis be made. One circumstance is to our advantage, we may safely take more time in studying a given case, and receive what benefit may be derived from continued observation.

Chronic infections—principally tuberculosis and syphilis—are responsible for a very considerable number of cases of focal cord lesions. These infections, however, do not act always in the same manner, either may act directly on the cord by destruction and replacement of medullary substance or by pressure from diseased vertebræ.

Syphilis.—The more common form of syphilitic transverse lesion is best described as meningomyelitis. Such a lesion occurs only in the course of a chronic spinal syphilitic meningitis. This form is rarer than formerly because it is a type of syphilis amenable to treatment. It should be readily recognized by other signs of syphilis of the nervous system and by the characteristic laboratory tests. "Charcot spine" and gumma of vertebræ are probably not so rare—at least the former—as is generally thought. One does not often find the diagnosis in card indices (only four times for the former in some twenty years at the Massachusetts General Hospital), but I can myself recall more than that number in the past six years.

CASE IV.—Mr. L. B., a patient with typical dorsolumbar tabes, was treated by me medicinally with benefit. He, however, still suffered from the effects of marked cord degeneration. The next year I was asked to see him because of renewed pains.

[1] Orr and Rowes: Review of Neurology, p. 345, 1907. Jour. Mental Sci., lx, p. 184, 1914.

Orr and Rowes and Stephenson: Jour. Mental Sci., lxi, p. 411, 1913.

His condition had changed markedly; he now complained solely of severe pains about the lower abdomen and there was found well-marked anesthesia to touch up to this level; although knee-jerks remained absent, he now presented also double Babinski sign. On examining the back a slight kyphos in the dorsolumbar

Fig. 188.—Charcot spine occurring in a patient with marked degenerative tabes. Symptoms of incomplete transverse cord lesion and presenting the "incomplete compression fluid."

region was visible and x-ray showed vertebral calcareous deposits characteristic of the condition seen in Charcot joint (Fig. 188).

Unfortunately Charcot joints (of all kinds) in my experience occur in the late degenerative stage of tabes, frequently in cases stationary (*i. e.*, negative) from the laboratory point of view. Hence we could theoretically—and actually this is borne out by

experience—expect nothing from antisyphilitic treatment. We must here rely solely upon the application of a brace.

Tuberculosis is rarely the cause of a transverse lesion from involvement of the cord itself, although one case of solitary tuberculosis of the lumbar cord appears in my series. Tubercular meningitis runs too rapid a course to become focal in character,

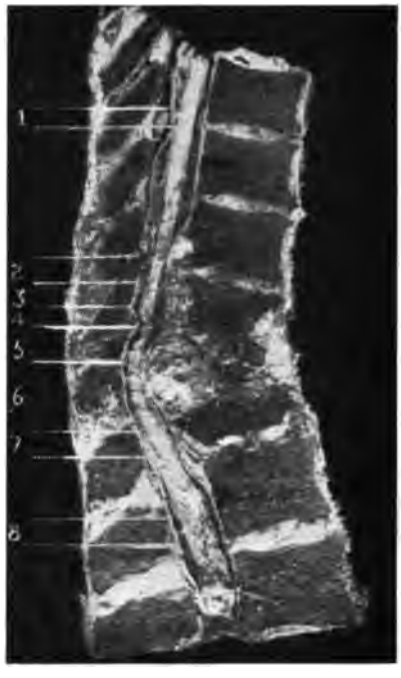

Fig. 189.—Hemisection of spine from seventh thoracic to second lumbar vertebra inclusive, showing tuberculous process especially developed at the eleventh thoracic vertebra. (Case of E. W. Taylor.)

and consequently its effects are too wide-spread to give transverse lesions. Pott's disease, however, is one of the commoner causes of pressure upon the spinal cord, but only when the tubercular focus bursts its vertebral borders is it in position to damage the cord (Figs. 189 and 190).

In Pott's disease the *x*-ray should be of great assistance, but occasionally, due perhaps to an inconveniently situated vertebra,

this fails, and perhaps even an operation may be performed on such a case for supposed cord tumor.

CASE V.—That operation is not a fatal mistake is shown by the case of a young woman in whom were signs of moderate pressure in the cervical region, spastic-ataxic gait, with level of cuta-

Fig. 190.—Cross-sections, showing areas of degeneration at the eight levels studied. (See Fig. 189.) Edinger drawing apparatus; accurate tracings. The defect in the sections, especially in 1, 2, 6, 7, is due to the fact that a preliminary hemisection of the spine with the cord *in situ* was made. The deformity of the cord, due to actual pressure, is shown in 4 and particularly in 5, being in sharp contrast to the well-preserved general contour of the other levels. (Case of E. W. Taylor.)

neous anesthesia, together with the incomplete spinal fluid syndrome. Operation revealed a bulging of the anterior dural wall and the probe unexpectedly revealed pus in the vertebral protrusion. Contrary to our fears, in this case the patient did not develop tubercular meningitis, although the dura had been

opened. Recently, three years after the operation, I have seen her, walking naturally and quite well.

Tumors exert pressure upon the spinal cord from without and from within, the symptomatology varying considerably with the different types.

Tumors of the vertebræ with pressure upon cord after erosion are usually metastatic, the breast furnishing one of the chief original foci. Pain from involvement of sensory roots is apt to precede cord pressure in such cases, at which time the diagnosis is not easy; when, however, the tumor has reached sufficient size to cause pressure the diagnosis is usually clear enough from examination and *x*-ray.

Tumors of the meninges and of the spinal cord itself, on the other hand, are often difficult of detection at any stage—to differentiate type and locus of such a tumor early is one of the fascinating problems of neurology. In the early detection of the presence of tumor, broadly speaking, as differentiated from some other disease of the cord, we are placing more and more reliance on the spinal fluid findings. Tumors early give the incomplete syndrome in most cases. Given, then, a case of probable pressure upon the cord, we search carefully for symptoms and signs for localization of level, waiting, if necessary, weeks or months for their development. Operation is then advised as the sole effective means of cure.

The following case, given in brief, represents a happy outcome of such a case:

CASE VI.—Miss N. L. in January, 1914, presented a partial Brown-Sequard syndrome of eight weeks' duration, and a probable diagnosis of syringomyelia was made. Spinal fluid clear, colorless, proteins much increased, cells 8, Wassermann negative. Gold sol, 0, 0, 1–2, 2, 2, 3, 2, 2, 1, 0. December, 1914: Increase of all cord symptoms, approaching "transverse myelitis." *x*-Ray of spine negative. Spinal fluid substantially the same. August, 1915: Level of transverse cord affection established at D. 4. Is now unable to walk. Double clonus and Babinski. Spinal fluid still shows incomplete pressure syndrome. Operation. Extradural endothelioma, size of Eng-

lish walnut, pressing on D. 6, and attached to dura; tumor removed entire. Complete symptomatic recovery.

More often, with similar symptoms, an irremovable tumor is found, as, for example, a glioma growing in the cord substance (Fig. 191), but with earlier and more accurate diagnosis even some of these intramedullary tumors may be operated upon with benefit.

Fig. 191.—Gliosis spinalis. Almost complete replacement of cord substance by gliosis, an incident in this case of the course of syringomyelia.

In the foregoing we have rapidly passed over a considerable array of pathologic entities, the one point in common among them being their capacity for producing focal affections of the spinal cord. It is most important for the proper treatment of patients suffering from such a highly destructive condition that an accurate diagnosis be made early and as accurately as possible. The separation into groups, as above given, with recognition of the chief types of disorder appertaining to these groups, in my opinion,

clears the mind for a differential diagnosis which, while frequently not certain, serves the purpose for action or inaction in a given case and a rational treatment in all.

Once more it is well to restate the importance of the best possible *x*-ray and most careful spinal fluid examinations as indispensable aids in establishing an early and accurate diagnosis of compression of the spinal cord.

CLINIC OF DR. RICHARD M. SMITH

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PYELITIS OF INFANCY

Definition; Occurrence; Symptoms; Signs; Pathology; Course of the Disease; Complication of Other Diseases; Mode of Infection; Illustrative Cases; Treatment.

BY the term "pyelitis" is meant an inflammatory condition of the pelvis of the kidney associated with bacteria and pus in the urine. It is sometimes called cystitis or pyelonephritis, and is to be differentiated from so-called acute hemorrhagic infection of the kidney.

Pyelitis is a very frequent disease, constituting about 1 per cent. of all cases coming to the physician dealing with children. It occurs at any age. The youngest case which I have seen was in a boy two days old; another was in a boy five days old. It is stated that the disease is much more frequent in girls than in boys. This is true after the sixth month, but before that time the difference in sex incidence is not very great. Beyond the sixth month there are about three times as many cases in girls as in boys.

The disease begins frequently with symptoms of the digestive tract—vomiting and diarrhea—and sometimes these persist for a considerable number of days and are severe enough to mask the real cause of the trouble. Urinary symptoms are usually very slight or absent. If present, they consist of frequency of micturition and sometimes of pain. There is often evidence of general discomfort quite possibly associated with abdominal pain. It is shown by irritability, sleeplessness, and refusal of food. Chills sometimes occur, and if they occur during the first year are practically pathognomonic of this disease. Chills are unusual in boys, but quite common in girls.

Physical examination rarely reveals any specific signs of this disease. Early in the disease temperature is usually present, it may be high and may continue for a variable length of time; from a few days to weeks. Pallor is usually present and may be of an extreme degree. There is also frequently general tenderness, greatest in the lower back, which may be confused with spinal disease. Sometimes the spleen is palpable. The diapers and clothes are often stained yellow by the pus in the urine, or brownish yellow if there is a good deal of blood. This staining, however, is not a constant occurrence, but is helpful when present.

The only sure sign of the disease is the finding of evidence of infection in the urine. It is advisable to examine more than one specimen of urine, as it not infrequently happens that a single specimen may be normal and a second specimen will reveal the disease. Albumin may or may not be present; its absence does not rule out pyelitis. The examination of the sediment is of primary importance. Usually an increased number of leukocytes will be found. More than three pus cells in the ordinary high dry microscopic field in girls and more than two pus cells in boys in the presence of symptoms described above warrant the diagnosis of pyelitis. Sometimes no cells or no increase of cells are found, but many organisms, usually bacilli, are present. If large numbers of motile bacilli occur in a fresh specimen, *i. e.*, one recently passed, or in a catheter specimen, the diagnosis of pyelitis is justifiable. When a secondary infection of the kidney occurs casts appear in the urine. Occasionally a hemorrhagic type of the disease is present in which there is a large amount of blood. This type is frequently difficult to differentiate from acute nephritis. The presence of many organisms and more leukocytes than would be accounted for by the blood favor pyelitis. Sometimes only the course of the disease can determine the diagnosis.

The failure to make a diagnosis of pyelitis is most often dependent on a failure to make a careful examination of the urine, probably because of the absence of urinary symptoms.

Pyelitis occurs not only as an independent condition but also

as a complication of other diseases, appearing in the height of the disease or subsequent to it. The examination of the urine often will explain a continued elevated temperature or a fresh rise in temperature during the course of the disease which otherwise was progressing satisfactorily. All children coming to the physician should have their urine examined, especially the sediment, in order that pyelitis may be either diagnosed or excluded as a possible cause of symptoms.

The following cases illustrate some of the many manifestations of the disease which have occurred in my own practice recently:

R. A. Seen when forty hours old. Baby was perfectly well until this morning, when he seemed to have some abdominal pain. The nurse took the temperature and found it to be 103° F. Physical examination was entirely negative except that the baby was slightly jaundiced. Movements consisted of meconium. No cause for temperature found. Cleaned out with castor oil. Temperature normal the next day, but rose again in two days, then came down to normal. Progressed fairly well for a month, then had a temperature of 102.8° F. again with a negative physical examination. A specimen of urine showed pus in considerable amounts. This was cured at the end of ten days by the administration of urotropin.

G. P. Age fourteen months. Negative previous history. Had no particular difficulty in feeding and had progressed satisfactorily. Without previous symptoms began to be irritable, fussy, and had a temperature of 103° F. A specimen of urine obtained was negative except for the presence of numerous motile bacilli. The temperature continued elevated. A second specimen of urine showed again many bacilli and an occasional leukocyte. The temperature remained elevated, sometimes going as high as 105° F., down to 102° F. for two weeks. The urine during this time showed no increase in cells, but showed repeatedly a marked bacilluria. At the end of two weeks the temperature dropped to normal and the urine was typical of pyelitis, with a large amount of pus. This patient was given urotropin together with the usual general and hygienic treatment, and

after several weeks the urine cleared and has remained so to date.

E. B. Age three years. Previous history unimportant. For about ten weeks she has been a little pale and somewhat constipated. Breath not good, A diagnosis of indigestion had been made and the fat reduced in the diet and iron given. She was a little better at first, but has continued to be pale and have a poor appetite. Never had any fever. Has lost 4 pounds. Physical examination negative except that she was a little pale. Routine examination of the urine showed four to six leukocytes in the ordinary high dry field and many motile bacilli. Was put on a full diet with 20 grains of urotropin every twenty-four hours, force fluids, and free evacuation of the bowels. Ten days later the urine contained a small amount of blood, apparently from the urotropin. The blood, however, disappeared with the omission of the drug. One month from the time first seen the urine was entirely normal.

M. T. Age seven years. Had been in excellent condition. Two days ago went to a children's party and has not felt well since. Given castor oil last night, which she vomited, and an enema this morning. Result contained a good deal of mucus. Temperature today 102° F. Physical examination entirely negative except for little superficial tenderness in the left side of the abdomen deep down. The urine showed pus in the sediment, otherwise negative. The temperature was normal in four days. The sediment was clear in one month. Was given forced fluids, rest in bed during the acute stage of the disease, and potassium citrate to make the urine strongly alkaline.

L. J. Age three years. Past history unimportant except that it was a premature baby. For the last six months every three weeks has had recurrent attacks of fever accompanied by vomiting, loss of appetite, and irritability. Has always been more or less constipated, and this condition is worse during the attacks. Recently the attacks have been more frequent, occurring every ten days. The urine had previously contained albumin and the protein had been cut down in the diet on that account. Physical examination was negative except that she looked pale.

Nothing abnormal in the abdomen discovered. Routine examination of the urine showed a few cells and many motile bacilli. Was put on a full diet and routine treatment of pyelitis with urotropin. Subsequent examinations of the urine showed frequently large amounts of pus and always many motile bacilli. In one month the sediment was normal. The "attacks of indigestion" have entirely disappeared.

E. A. Age eight years. Always been a well and strong child. Ten days ago began to have frequent micturition, and at this time the urine was acid. Sediment not examined. Given something to make the urine alkaline and nothing further thought about this condition. Six days ago had a temperature of 103° F. and complained of a good deal of pain low down in the abdomen. The next day the temperature came down, and she seemed better. The day after she had a good deal of general tenderness everywhere, and was discovered to have a slight vaginal discharge. The next day she seemed better in the morning, but in the afternoon she complained of pain in the abdomen. Question of an appendix. Blood count 20,000. Urine at this time contained a good deal of pus. The next morning the tenderness was on the right side of the abdomen. Temperature 104° F. Had a slight chill. When seen was lying comfortably in bed. Complained of pain in upper part of the abdomen. Examination outside of the abdomen was negative. Abdomen was held rigidly without any tenderness over the appendix. Nothing definite could be made out anywhere. The urine showed a large amount of pus and an occasional red cell and a few bacteria. The smear from vagina was negative for gonococci. Large doses of urotropin, with forced fluids, rest in bed, light diet, and open bowels prescribed. A little later a good deal of blood appeared in the urine. Given potassium citrate for a few days, then returned to the urotropin. After several weeks the child recovered and has had no subsequent attacks.

R. H. Age fifteen months. Previous history negative except that at eleven months she had a convulsion. For several weeks ran a high temperature and seemed very nervous, from which she recovered. Did well for three weeks, then she had

another convulsion. This was followed by German measles one week ago. Has entirely recovered from that. Has alwayd had a tendency to constipation. A specimen of urine obtained today showed a considerable amount of pus. Physical examination entirely negative. Temperature 100½° F. Given urotropin, forced fluids, light diet, open bowels, and general hygiene. After four days the urine was clear and remained so for two weeks, when she had another rise in temperature, with the reappearance of pus in the urine.

M. P. Age fifteen months. Previous history unimportant except is convalescing from whooping-cough. No digestive disturbances except tendency to constipation. Four days ago began to have a temperature and the movements were bad. Given castor oil and enemas. Did not vomit. Movements green and slimy. During the next two days vomited several times, and the movements continued to be bad. The temperature was elevated, grew very pale, and abdomen became distended. Seemed quite sick. When seen at this time the physical examination was negative. Urine showed many pus cells and many motile bacilli. Given urotropin, forced fluids, rest in bed, free catharsis, and in seventeen days from the first rise in temperature the urine was practically clear. Subsequent examination showed an occasional pus cell, but there was no return of symptoms. Further examination of the urine revealed a clear sediment and has remained so.

M. P. Age three and a half years. Has always been well. No digestive trouble. No fever of any sort. Five weeks ago the child had a convulsion in the morning, lasting four or five minutes. Had another one that day, another at night, and one in the evening. The next day seen by a physician in London, where they were at the time, who could find nothing on physical examination to account for the trouble. Was put on a limited diet, but a few days later had another attack which was slighter. Had no return of the trouble until seventeen days ago, when she had another slight convulsion which was rather different in character. No rigidity, no cyanosis, but a little twitching, lasting a few minutes. Came home three days ago. Stood the jour-

ney very well. Yesterday morning had a slight convulsion with almost no loss of consciousness. Since the onset of the first convulsion quite frequently, as often as once or twice a day, she has had times when she would draw back her head or drop an article if she had it in her hand. No real loss of consciousness. No staring, and not really typical of petit mal. No loss of sphincter control. She has had no other symptoms than those described above. Has had no headaches. No vomiting and no digestive symptoms. Seems in perfect health. Physical examination at this time was entirely negative. Routine examination of the urine showed a slight increase of cells and nothing else. Was put on a careful diet, given general directions for hygiene and care. The attacks continued without interruption. Frequent examinations failed to reveal anything further. Frequent examinations of the urine, however, showed an increasing number of pus cells. She was given potassium citrate and after about a month the urine was entirely clear. With the disappearance of pus from the urine, the attacks described above entirely ceased. There were two or three relapses of the attacks always associated with relapses of the pyelitis. For the last year there has been no pus in the urine and has had no further attacks.

B. D. Age eleven months. Well up to three weeks ago, when she had a little time of crying, fussy, with slight elevation of temperature. She apparently entirely recovered from this. Last three or four days has been fussy and has vomited three times. Vomiting has now ceased. The temperature is still elevated. Given water, barley-water, and broths. Stools have been normal. Objects to being handled. Has lost a great deal of weight. Temperature is 103° F. Physical examination is negative except that she looks pale and cries if disturbed The urine showed pus. Given forced fluids, open bowels, and urotropin.

M. P. Age eleven months. Previous history unimportant. Always been well. For four or five days has been rather fussy. Little temperature. Refusing some of food. Temperature is 104° F. Physical examination entirely negative except that she is pale. Previously has had excellent color. Examination of the

urine showed a moderate amount of pus. Was put on a light diet, forced fluids, open bowels, with potassium citrate. At the end of two months the urine was entirely normal and has remained so since.

Pathologically, pyelitis shows only an inflammatory reaction at the pelvis of the kidney, consisting of an increased number of cells and the presence of bacteria. The substance of the kidney is normal unless it becomes secondarily infected from the pelvis of the kidney. When such a secondary infection occurs there may be a very marked destruction of the kidney resulting in the prolonged and severe cases in practically entire destruction of the organ. The kidney function is decreased during the acute and early stage of the disease, but subsequently, unless there is a secondary infection of the kidney itself with destruction, the function is normal.

Cultures from the urine show the presence of virulent organisms. In about 75 per cent. of the cases colon bacilli are found. In the remainder a variety of organisms—streptococci, staphylococci, and others—are found.

The course of the disease is variable. The children with acute and severe symptoms in general do better than those with a less virulent onset. The acute stage usually lasts only a few days, or rarely weeks, during which time the temperature is elevated. After the fall in temperature the urine still shows the presence of bacilli or cells. The tendency of the disease is to become chronic. Relapses occur without apparent cause, but are frequently associated with acute infections even a considerable time after the attack. Considering these facts, it is difficult to say when a given patient is cured. When bacilli are present in the urine in considerable numbers, as can be easily determined from a stained centrifuged specimen, and when cells are present in the sediment, even though the patient is without symptoms, the disease cannot be called cured. If, however, the urine is sterile and there are no symptoms the case is certainly cured. The patient may be cured so far as the need of treatment is concerned, even though a catheter specimen of the urine shows the presence of organisms.

Pyelitis without complications is almost never fatal, but in protracted cases intercurrent infections, especially pneumonia, are common.

There has been much discussion as to the mode of infection of pyelitis, *i. e.*, how the organisms get into the pelvis of the kidney. Three main theories have been advanced: first, ascending; second, direct transfer from the colon; third, blood.

In the ascending infection it is assumed that the organisms enter the urethra, then the bladder, pass along the ureter into the pelvis of the kidney. This theory is advanced because of the greater number of cases in girls, and the fact, with the short urethra and its easy contamination, would seem to suggest this mode of infection. There has been no conclusive experimental work to support this theory, and a considerable amount of work has been done to prove the impossibility of infection in this manner. It seems to me that although theoretically it is a possible mode of infection, practically it is not to be considered.

Direct transfer of bacteria from the colon to the kidney via the lymphatics is possible. It has been shown by anatomic studies that there is a direct lymphatic connection between the colon and the kidney. This connection is more intimate on the right side, and pyelitis when unilateral is more common on the right side. So far as this evidence goes it indicates that this may be a possible means of infection.

Recent work has tended to establish the blood as the usual means of infection. The probable course is somewhat as follows: The organisms enter the blood from the intestinal tract or other parts of the body. Entering the blood directly or through the intermediary of the lymphatics, they pass with the blood into the kidney, through the glomeruli, down the tubules, and out at the pelvis. During the passage through the kidney they may or may not cause an infection. What happens depends upon the virulence of the bacteria and upon the general resistance of the patient and the local resistance of the kidney. Colon bacilli have a low pathogenicity, therefore rarely cause infection in the kidney. In being excreted at the pelvis an inflammatory process occurs, causing the disease pyelitis. There may be an

infection of the kidney by extension inward from the pelvis via the lymphatics, but it is not directly associated with the primary condition. A large amount of experimental evidence has been collected to substantiate this mode of infection, and all the various steps in the process have been shown possible of occurrence.

The discussion of the mode of infection has more than an academic interest, because if this third method, namely, via the blood, is the true method, as I believe it is, it indicates that we must search out the portal of entry of the bacteria if we are to treat the disease intelligently or be successful in preventing its occurrence.

The intestinal tract is undoubtedly the source of infection in the majority of instances. The close connection between the intestinal tract and the disease is shown by the great frequency of pyelitis as a complication of the acute intestinal infections in infants. The mucous membranes about the vagina and penis where colon bacilli are present in large numbers furnish also a possible source of infection in many cases. This is particularly true where there is local irritation causing excoriation. Suppuration or infection anywhere in the body may furnish the portal of entry for bacteria into the blood-stream. The following cases suggest these various sources:

J. M. Age five days. Normal at birth and normal delivery. Two days ago had a temperature of 104° F., down to 101½° F. yesterday afternoon, but is 104° F. today. Has lost weight steadily since birth, although mother seems to have plenty of milk. Took food well until today, when he has not taken it so well. Given a teaspoonful of castor oil yesterday. When seen was jaundiced. Did not look sick. Physical examination was negative except for five or six pustules on the right side of neck. The skin condition was given appropriate treatment. A specimen of urine obtained showed a large number of pus cells, many of them embedded in mucus, and many cocci. Was given urotropin, force fluids, and the urine entirely cleared. It is possible that the impetigo was the source of infection in this case.

C. H. Age fourteen months. Previous history unimportant.

Has done very well. Never been able to take orange-juice because of burning movements. Was given orange-juice day before yesterday, and yesterday had two or three loose stools which caused marked excoriation of the buttocks. This morning had a temperature of 102° F. and is very fussy. Physical examination except for the local condition of the buttocks was entirely negative. The urine showed a large amount of pus and many motile bacilli. Was given urotropin and the temperature came down to normal in two days. At the end of ten days the urine was normal and has always remained so. It is quite possible that the excoriation around the buttocks furnished the portal of entry for the bacteria in this case.

E. O. Age two weeks. Normal birth. Artificially fed because the mother died at birth. Was fairly well nourished. In a good condition except for a marked excoriation around the vulva, inner side of thighs, and back. Routine examination of the urine showed many pus cells and bacilli. Was given urotropin, forced fluids, and light diet. The urine cleared rapidly.

F. L. Age two years. Previous history unimportant. Has always done perfectly well. Yesterday began to have a slight cold. Temperature 102° F. Glands in both sides of neck swollen. Physical examination except for a reddened throat and the enlarged glands in neck was negative. This case was one of a septic sore throat epidemic due to milk. The throat pursued its usual course. Routine examination of the urine showed five days after the onset a typical pyelitis. The throat and the urinary condition progressed favorably and was entirely cured at the end of three weeks.

The **treatment** of pyelitis consists in rest in bed during the febrile stage, in general hygiene, and in the use of certain drugs. It is of the greatest value to pay attention to the condition of the bowels. The disease is frequently associated with chronic constipation. Attacks may recur or grow worse when constipation is present. Therefore, as a means of prevention and of treatment, a free evacuation of the bowels should be accomplished each day.

Acute general infections undoubtedly lower the resistance of the individual and thus give the colon bacilli or other bacteria

which may be passing through the kidney a chance to set up an infection. The local infections, such as nasopharyngitis, carious teeth, furuncles, etc., furnish possible sources of disease. Every means should be employed to increase general resistance and to remove possible portals of entry for bacteria. Fluid should be taken in more than the usual amount, not less than 3 pints in the twenty-four hours, to prevent the concentration of bacteria.

In the acute or early stage of the disease hexamethylenamin or urotropin is the drug to use. This should be given in sufficient amounts to produce results, even though it causes vesicle irritation or hematuria. No permanent damage is done and it is better to push the drug to a point where results are obtained than to give small doses for fear of producing hematuria. The urine should be tested to be sure that formalin is present. It is to be remembered that formalin is liberated only in acid urine, so that unless the urine is acid, either acid sodium phosphate or sodium benzoate should be given. The number of grains of urotropin to be given in each twenty-four hours depends upon the individual case, but infants under one year can be started at 20 grains in the twenty-four hours and the dose increased from this point if necessary. When urotropin is not effectual, potassium citrate or sodium bicarbonate may be given to render the urine alkaline.

Sometimes the rapid varying of the reaction of the urine from acid to alkaline will make the growth of the colon bacilli in the urine less easy, and thereby influence favorably the course of the disease.

Vaccines have been tried in this condition, but I have not been convinced that they are of any value. If used, they should be used in large doses, and discontinued if no good results are obtained after three or four doses.

In older children local application of silver salts to the pelvis of the kidney may be effectual in very stubborn cases. This method of treatment is inapplicable in children under six years of age.

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THE CAUSE AND TREATMENT OF BRONCHIAL ASTHMA

A Discussion of the Facts which may be Elicited from the Patient by a Careful History; the Relationship between Anaphylaxis or Protein Sensitization and Bronchial Asthma; a Test for and the Discussion of Protein Sensitization in Asthmatics; a Clinical Classification of Bronchial Asthma; the Presentation of Cases Illustrating the Different Types and Causes of Bronchial Asthma According to this Classification and a Discussion of the Treatment of Bronchial Asthma.

SINCE the present methods of determining the cause and treatment of patients with bronchial asthma are of recent origin and are not generally known it seems advisable before the presentation of cases to show how a case of bronchial asthma is analyzed; in other words, how one determines the cause of bronchial asthma in a patient.

A very careful history relative to the disease in each patient is essential; the following facts, although not infallible, are of great help and may be elicited from the patient. The age of onset of asthma is very important. The onset of asthma during the first year of infancy should lead one to suspect milk as the cause; onset during the second year of age is due usually to eggs, cereals, and wheat flour, frequently to bacteria, and rarely to other substances. The presence of eczema with asthma is very strong evidence that some food is causing both eczema and asthma at this early age. Throughout childhood between the ages of two and twelve the frequency of foods as a cause of asthma gradually decreases with age and the frequency of bacteria as

a cause gradually increases. During this period of years the acute infections of childhood play a great part in the cause of asthma. Chiefly among these infections are whooping-cough, measles, and severe prolonged colds, all of which usually have bronchitis as a complication or sequel, and the bronchitis predisposes to asthma; naturally, bacteria are the true cause of asthma in such conditions. During childhood two additional causes of asthma present themselves: exposure to animal emanations and to plant pollens. Between the ages of twelve and forty foods are rarely, and bacteria are usually, the cause of asthma. During this period of life the onset of asthma is usually associated either with repeated attacks or with one prolonged attack of bronchitis, with frequent head and chest colds, and occasionally with other acute infections. Plants and animals are also frequently the cause of asthma at this time. Of the animals, the horse is the chief cause and the cat is a frequent cause; other animals play a minor rôle. Of the plants, it is chiefly those which pollinate during the summer months, therefore the asthma caused by plants is a summer type. The pollen of red top and timothy is usually the cause of that type of asthma which patients have only during June and July, and the pollen of ragweed and golden-rod is the chief cause of that type of asthma which patients have only from the middle of August to the first frost. The pollen of daisy may link together these two types of summer asthma, so that asthma may be continuous from early in June to the first of October, in which case the pollen of these five plants is the cause. Occasionally this summer type of asthma is so violent that there is a resultant bronchitis and consequently bacteria may prolong a true pollen asthma for months or even throughout the year. The onset of asthma after the age of forty is practically always caused by bacteria, and the asthma usually manifests itself at first as a bronchitis which gradually increases in severity. Naturally after the age of forty disease of the heart and kidneys may play an important rôle in the cause of asthma; physical examination, however, will verify or eliminate these and other organic causes. With the exception of bakers (inhalation of wheat and other cereal flours) and care-

takers of horses, occupation, as a rule, has little bearing on the direct cause of asthma. Although heredity may predispose to asthma, it has no bearing on the causative agent. Asthma recognizes the four seasons of the year. A small group of patients have asthma only during the winter months when the air is clear and cold; a large group of patients have asthma only during the spring (March and April) and fall (October and November), months when the weather is very changeable and unsettled. These seasonal types of asthma practically always are associated with bronchial colds and bronchitis, and obviously bacteria are the primary cause. In a few instances the summer type of asthma is caused by bacteria; bronchitis is an important factor.

Having outlined the various causes of asthma, we may now consider the sources of entrance into the body. There are three sources: inhalation, ingestion, and infection. Inhalation takes place through the respiratory tract and chiefly concerns the pollen of plants, the emanations, hair and skin excoriations of animals, and in the case of bakers and housewives the inhalation of the flour of the cereal grains. Ingestion has to do with the eating of foods, and we know that, for some not well-understood reasons, foods after entering the gastro-intestinal tract do cause asthma. By infection we mean the presence of pathogenic bacteria in any part of the body, but such foci are usually present in the teeth, tonsils, nose, throat, and lungs.

We know that foods, bacteria, plant pollen, and the excoriations of animals are very complex substances, and that many different elements make up their complex. Therefore it must be determined what part of these substances enter into the cause of asthma. Fortunately, this problem has finally been settled as a result of prolonged investigation, and we now know that it is the protein in these substances that causes asthma. (In the case of bacteria, however, besides the protein element we also have the infectious element, which will be considered later on.) We will now briefly outline the development of investigations which associates proteins with the cause of bronchial asthma; these showed that patients may be sensitized to proteins, that proteins are responsible for anaphylactic shock, and that ana-

phylactic shock in animals simulates an attack of bronchial asthma in the human. The earliest observation having direct bearing on protein anaphylaxis is found in the writings of Magendie in 1839. He describes the sudden death of dogs which had been repeatedly injected with egg-albumen. Richet in 1902 made a systematic study of this problem and found that the first dose of protein was followed by a condition of markedly greater susceptibility to the protein. He called this phenomenon "anaphylaxis" to express its antithesis to prophylaxis or protective effects. As a result of the work of many other investigators from this time on we now know that when a specific antigen (a protein in the case of asthma and anaphylaxis) meets its antibody the reaction between them gives rise to a toxic product, and this causes the characteristic symptoms known as anaphylactic shock. In 1910 Meltzer pointed out that in both bronchial asthma and anaphylaxis the symptoms consist in a tonic stenosis of the small bronchioles, and that both conditions are favorably affected by the administration of atropin.

From the work of many investigators we now know a considerable amount about anaphylactic shock in animals. In our study of bronchial asthma we have been able to show to a certain extent that a similar type of anaphylactic shock plays a rôle in asthma in man. If a bronchial asthmatic who is sensitive to some protein be injected subcutaneously with a small amount of this protein, he will have shortly an attack of bronchial asthma. He has difficulty in expiring, but at first no difficulty in inspiring. Later, as the lungs become overdistended, there is difficulty also in inspiration. If the patient is examined with the fluoroscope at the time he is struggling for breath, we find that the lungs do not move and that the diaphragm is stationary in a depressed position. Immediately following an injection of adrenalin chlorid, however, the lungs are seen to expand, the diaphragm moves up and down with respiration, and the patient's dyspnea abates. Furthermore, an analysis of the patient's alveolar air during the paroxysm of difficult breathing shows that the alveolar air has a low carbon dioxid content, although the blood at the same time shows a normal carbon dioxid content. Following

the injection of epinephrin chlorid, which relieves the difficult breathing, the carbon dioxid content of the alveolar air gradually returns to the level of that in the blood. Thus attacks of bronchial asthma and anaphylactic shock are similar, in that both may be caused by proteins, and the symptoms are similar, in that there is labored respiration. Pathologically, the two conditions are alike, in that there is distention of the lungs, and furthermore in animals there is a stenosis of the bronchioles, and in the human body there is evidence of this from the carbon dioxid content of the alveolar air. And, lastly, both conditions are relieved by injections of epinephrin chlorid.

Having thus shown that it is the protein element in substances which may cause asthma we must next consider how it is possible to ascertain whether or not some particular protein may really be the cause of asthma. There are two tests which may be applied to the patient in order to determine protein sensitization. One of these is an intradermal test, which we will not describe since we consider it to be impracticable and erratic. The other test is known as the skin or cutaneous test, and since we have found this test to be practicable and reliable a description of it will follow:

A number of small cuts, each about $\frac{1}{8}$ inch long, are made on the flexor surfaces of the forearm. These cuts are made with a sharp scalpel, but are not deep enough to draw blood, although they do penetrate the skin. On each cut is placed a protein and to it is added a drop of tenth-normal sodium hydroxid solution to dissolve the protein and to permit of its rapid absorption. At the end of a half-hour the proteins are washed off and the reactions are noted, always comparing the inoculated cuts with normal controls on which no protein was placed. A positive reaction consists of a raised white elevation or urticarial wheal surrounding the cut. The smallest reaction that we call positive must measure 0.5 cm. in diameter. All larger reactions are noted by a series of plus marks, and any smaller reaction is called doubtful. As evidence that the skin test is satisfactory and conservative we have found by treatment with subcutaneous injections of proteins that we cannot inject a patient with a stronger solu-

tion of a protein than that which gave a positive reaction without producing an attack of asthma.

A few words seem necessary in regard to multiple sensitization or sensitization to two or more unrelated proteins. We find that the same patient may be sensitive to, and his asthma may be caused by, any combination of the proteins derived from plant, animal, food, or bacterial sources. We have found that most patients who are very sensitive to the proteins in horse dandruff are somewhat sensitive to the proteins in cat and dog hair. Only 20 per cent. of those patients that are sensitive to horse dandruff are also sensitive to horse-serum protein, so that a very small percentage of asthmatics are sensitive to horse-serum and the danger of injecting an asthmatic with moderate amounts of horse-serum, such as antitoxin, is confined to only a rare case. Horse asthmatics should not be given large amounts of horse-serum intravenously without previously testing the patient with horse-serum and horse dandruff; this naturally applies at the present time to antipneumococcus serum therapy. If the asthmatic is sensitive to horse dandruff proteins and not to horse-serum, he may be injected slowly with as much as 60 c.c. of horse-serum before signs of an asthmatic attack develop, and if the injection is stopped at this time no serious results follow, and the asthma, if it develops, is controlled by adrenalin chlorid. If, however, the asthmatic is sensitive to horse-serum, a subcutaneous injection of as small an amount as 0.25 c.c. of antipneumococcus serum will produce violent asthma. Such a patient may be desensitized and protected against horse-serum by frequently repeated gradually increasing doses of horse-serum given first subcutaneously and later intravenously, so that the patient may be given 60 c.c. or more of antipneumococcus serum intravenously before symptoms of asthma appear. This method of desensitization with horse-serum protects against horse-serum for many weeks, but it protects against horse dandruff proteins for only a day or two, indicating that injections of horse-serum are of little or no value in the treatment of horse asthma. The sensitization of patients to different tissues or fluids of the same animal also varies. Taking, for example, the beef animals, the

same patient may be sensitive to any one alone or to any combination of the following tissues or fluids, namely, meat, milk, serum, and hair. Patients differ in their sensitization to the individual proteins of the same cereal, for instance, the same patient may be sensitive to any one alone or to any combination of the individual proteins of the wheat kernel; such proteins, however, are too closely related to be called multiple sensitization. Even the amino-acids give a positive skin reaction.

Multiple sensitization is very common, and such cases are the most difficult to treat. Thus it is seen that it is necessary to test the patient with an almost unlimited number of proteins before one can say that that patient is not sensitive to proteins. For practical purposes, however, such an outlay of proteins is not necessary, since the majority of sensitive patients with bronchial asthma are sensitive to the proteins of horse dandruff, Staphylococcus pyogenes aureus, wheat and other cereal flours, the pollens, Staphylococcus pyogenes albus, cat hair, and egg, all of which have been named in the order of frequency of sensitization. A few patients are sensitive to the protein of milk, feathers, chicken meat, beef, potato, and wool.

We will not describe the methods of isolating and preparing the various proteins, since such proteins are on the market and may be purchased from manufacturers. When such proteins are not available the crude substances may be used in the skin test; for instance, uncooked egg, flour, etc., a 12 per cent. alcoholic extract of animal hair and of pollens, a weak alkaline extract of dried bacteria.

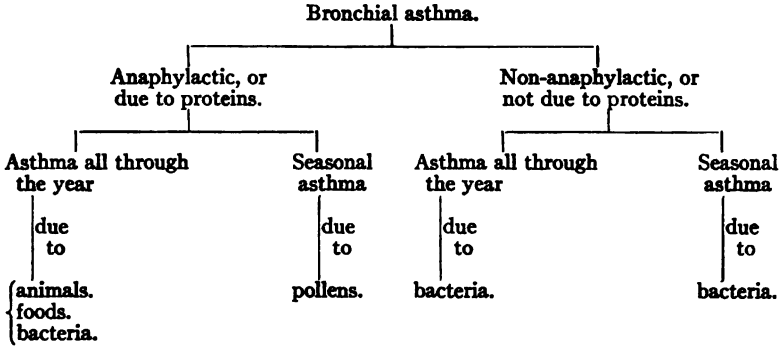
With the exception of bacteria, negative skin tests with proteins rules out those protein substances as a cause of asthma, and a positive skin test with a protein should make one suspect that protein as a cause of asthma. Frequently one meets with a patient who gives a positive skin test with some protein, but at that particular time that protein may not be the cause of asthma; however, at some previous or future time that protein probably has been or will be the cause of asthma, and, consequently, that protein should be eliminated. No patient that had onset of asthma after the fortieth year of age has given a

positive skin test, and one-half of the sensitive patients began to have asthma previous to the age of twenty; quite opposite to these statements is the fact that 40 per cent. of the non-sensitive patients had onset of asthma after the fortieth year of age, and only 15 per cent. had onset of asthma previous to the age of twenty. These statistics thus seem not only to separate bronchial asthma into two types, namely, a sensitive and a non-sensitive, but they are of value in determining the cause and the treatment of bronchial asthma. For instance, the patient that has onset of bronchial asthma early in life is usually sensitive to some protein, and the patient that has onset of asthma after the age of forty is not sensitive to proteins, and in the latter chronic bronchitis is almost always a complication or cause, and cardiorenal disease is frequently a complication or a cause of asthma.

In the case of bacteria, besides the protein element which will be excluded or included as a cause of asthma by the skin test, we have the infectious and inflammatory element entering into the cause of asthma. In discussing the importance of a careful history from the patient we emphasized the relation of asthma to colds, bronchitis, and infections; thus such a history would lead one to suspect the bacterial cause of asthma even though the skin test was negative to bacterial proteins. Obviously, a careful search for bacterial foci should be made with each patient, and such foci are frequently found in the teeth, tonsils, throat, etc. Naturally, cardiac disease, renal disease, and other pathologic conditions must be excluded as a cause of asthma.

From a careful history of the patient and the employment of the skin test we may classify the causes of bronchial asthma. Although such a classification is not infallible, it serves as a good working basis.

CLASSIFICATION OF CAUSES OF BRONCHIAL ASTHMA



We will now present 6 patients with bronchial asthma. The first 3 patients illustrate sensitization to proteins (Case 1 to horse dandruff, Case 2 to foods, Case 3 to bacteria) causing asthma throughout the year; we will not present a case of summer asthma due to pollens, since this type of case is readily recognized. The second group of 3 patients are illustrative of the non-sensitive type of asthma, and bacteria was the cause. Case 4 illustrates the all-the-year type of asthma due to bacteria, Case 5 illustrates another all-the-year type of asthma due to bacteria, but associated with bronchitis in a patient who has cardiorenal disease, and Case 6 illustrates the seasonal type of asthma due to bacteria.

BRONCHIAL ASTHMA CAUSED BY AND TREATED WITH PROTEINS

CASE 1.—D. G., a maid aged twenty-two, began to have asthma one year ago. The first attack was two weeks after an injection of antitoxin. At first she had asthma nearly every night, but shortly the attacks became periodic, although she was never free from asthma for more than a month. Since the onset of asthma the patient has taken cold easily, has had a cough all of the time, and has much expectoration. The patient has lost 30 pounds in weight, is very weak, cannot walk upstairs or on a level for any distance without having asthma. She cannot lie down without wheezing. At times she has raised bloody sputum

and was thought to have tuberculosis, but repeated examinations of her sputum have failed to reveal tubercle bacilli. She has asthma when riding behind horses, but previous to the injection of antitoxin horses gave her no trouble.

Skin reactions were positive with an alcoholic extract of horse dandruff; the coagulated protein of horse dandruff was positive in a dilution of 1 : 100, and the alkali metaprotein was slightly positive in a dilution of 1 : 100,000. The protein of horse-serum gave a negative test.

Treatment was begun on September 8, 1916, with 2 minims of a dilution of 1 : 1,000,000 of horse dandruff alkali metaprotein subcutaneously. The following week 5 minims were given, and after this the patient was able to lie down without wheezing. For the next four weeks treatment was continued with gradually increasing amounts of this protein dilution. The patient was now free from wheezing, had less cough, and less expectoration. On October 27th the dilution of protein was changed to 1 : 100,000, and of this 2 minims were given. The patient was now able to walk up hill without wheezing. The next week 4 minims of this dilution were given; a few hours later the patient had a bad cough, asthma, and had to sit up in bed and gasp for breath. Her arm was very sore. It is noted that the last treatment was double the amount of protein which was given the previous time, and evidently this sudden increase caused the bad attack of asthma. On November 10th the second previous dose, namely, 2 minims of the protein in a dilution of 1 : 100,000, was given. The next week the amount was increased to 3 minims, and a week later it was increased to 4 minims. No inconvenience was experienced this time, even the arm was not sore, so that by gradually increasing the dose of protein no trouble resulted, but following a doubling of the previous dose a severe reaction resulted. The patient was now feeling stronger and was able to walk to the street car two miles distant. Five more weekly treatments were given subcutaneously with this dilution of the protein. At the end of this time the dilution of the protein was changed to 1 : 10,000, and each week the dose was gradually increased until ten doses had been given. The patient now felt

perfectly well, and had gained 32 pounds in weight. She was able to ride behind a horse without having asthma. During the next three months treatment was continued with gradually increasing amounts of a 1 : 1000 dilution of the protein, and finally four treatments were given with a 1 : 100 dilution. At this time the protein which previous to treatment had given a positive skin test in a dilution of 1 : 100,000 now gave a negative test with a 1 : 100 dilution. The patient has continued free from symptoms. Treatment was discontinued. Four months later the patient reported that she still continued to be free from symptoms.

Discussion.—Since the onset of asthma in this case was during early adult life, we would suspect that it was caused by some protein, but not by a food protein, and, furthermore, the patient did not have eczema. On the other hand, the severity of the bronchitis as evidenced by cough, much expectoration which at times was bloody, marked loss of weight and strength, all of which had pointed to tuberculosis, would lead one to suspect that bacterial infection might be the primary cause of asthma rather than a secondary cause, as it was proved to be. In order to treat the patient with horse dandruff protein it was necessary to do skin tests with a series of varying dilutions of the protein to find out what amount of the protein could safely be given to the patient. Since a dilution of 1 : 100,000 of the protein gave a positive skin test, and the next higher dilution gave a negative skin test, it was safe to begin treatment with the latter dilution. The importance of slowly increasing the desensitizing dose of protein is shown. While the amounts of protein were slowly increased the patient had no trouble and improvement was steady; however, when a sudden increase in the amount of protein was given (as occurred on November 3d) asthma followed a few hours later. The rapid improvement of the patient while under treatment is very striking. When the skin tests became negative with horse dandruff proteins treatment was discontinued and four months later the patient was still well.

CASE 2.—G. B., a girl aged seventeen, first had spasmodic asthma at eighteen months of age and it continued for years.

In recent years she has had continual asthma and bronchitis with much cough and expectoration. Because of constant wheezing which is aggravated by exertion the patient goes out of doors very little. She has had eczema since six months of age.

The patient's mother and a brother had asthma at three years of age and a maternal grandmother and a paternal uncle had asthma.

Skin reactions were positive with alcoholic extracts of horse dandruff, cattle hair, and wool, with the protein of Staphylococcus pyogenes aureus and albus, with the pollen of red top, timothy, ragweed and golden-rod, and with the various proteins of wheat.

The patient was given subcutaneously 3 minims of whole wheat protein in a dilution of 1 : 500 and much improvement followed. Following 8 minims of this dilution given a week later she was much worse. The next week only 5 minims were given and she had a good week; this was repeated a week later and she became free of wheezing. All treatment was omitted and the patient was put on a wheat-free diet. She began to gradually improve and during the third week she became free from asthma and eczema was improved. The following week by mistake the patient ate some wheat and had a relapse of asthma. After avoiding wheat again for a week she again began to improve until she became free of wheezing. A second time the patient ate wheat without knowing it, until after it was too late, and she had another relapse. Finally, the patient went four months without eating wheat and she became free from wheezing and her cough and eczema were improved. Since she continued to have considerable bronchitis, the patient was given for two months an autogenous sputum vaccine and during this time cough and expectoration gradually decreased. Since the patient was sensitive to pollens, it was essential to desensitize her against them. Therefore during April and May the patient was treated with the pollen of red top and timothy and during June and July with the pollen of ragweed and golden-rod. The patient went through the summer without asthma and she had only a slight bronchitis.

Discussion.—This case illustrates the very early age of onset of asthma from foods and the association of eczema. It also illustrates multiple sensitization. Since the patient became free from asthma when wheat was omitted from the diet, it would seem that wheat was the primary cause of asthma and that the other proteins to which the patient was sensitive played no part at the present time. The case well illustrates the difficulty in keeping anyone on a wheat-free diet and the difficulty in attempting to desensitize a patient with wheat proteins. Although the patient was relieved of asthma and wheezing while wheat was omitted from the diet, she still continued to have bronchitis which was greatly improved by vaccines. On comparing this case with the former one we note that in the former both asthma and bronchitis were relieved by protein treatment, but in the latter only asthma was relieved and the bronchitis required vaccine treatment.

CASE 3.—M. L. S., a dressmaker aged thirty-one, was subject to colds and bronchitis in childhood. Since the age of twelve the patient has had attacks of asthma with colds. At first she had four attacks of asthma each year, one in the fall, one in the spring, and two in the winter. Later she began to have indigestion and gas on her stomach, with attacks of asthma, and she thought that certain foods caused this indigestion and asthma. During the past few months she has had headache and vomiting with attacks of asthma which now come more often at night. Cold air, dust, wind, and exertion provoke wheezing, and asthma and menstruation seem to come together. She has to burn an asthma powder every day or night, and frequently several times.

The patient's brother and a maternal first cousin have asthma and her maternal grandmother had asthma.

Skin reactions were positive with the protein of Staphylococcus pyogenes aureus, all other proteins were negative.

Treatment was begun with 200,000,000 of stock Staphylococcus pyogenes aureus vaccine, a week later 350,000,000 were given, and two weeks later 500,000,000 were given. Following each of the last two treatments the patient had wheezing for two days, so that the amount of vaccine was reduced to 200,000,-

000. During the next two months the patient was given at weekly intervals gradually increasing amounts of this vaccine, beginning with 200,000,000 and ending with 1,000,000,000. During this time she had no wheezing or asthma, she was free from indigestion, was able to work every day, and dust, wind, and exertion caused no trouble. Treatment was discontinued and the patient remained free from all symptoms for three months. At the end of this time she had a severe cold with asthma, cough, and much expectoration. Treatment was begun again with stock Staphylococcus pyogenes aureus vaccine and was continued as previously for four months. During the first month of treatment she had slight wheezing at times and cough and expectoration gradually decreased; during the last three months of treatment she was free from all symptoms. Nine months later the patient reported that she had been free from asthma all this time.

Discussion.—This case illustrates asthma associated with colds and bronchitis in a young adult who had a previous history of frequent colds and bronchitis for years. Since the patient was sensitive to the protein of Staphylococcus pyogenes aureus, stock vaccines of this organism were given, and during such treatment the patient became free from asthma, cough, and expectoration, and remained free for five months, during the latter three months of which time she was given no treatment. When asthma returned again with a long-continued cold she was again relieved of it by similar treatment, and she has continued free from symptoms for a year. It is noted that permanent results did not follow the first course of treatment, but a relapse occurred three months after treatment was stopped. Since the second series of treatments, however, the patient has continued free from symptoms for a year. It is interesting that this patient associated asthma with indigestion for which she blamed certain foods, but that successful treatment relieved her of these symptoms even though she ate these same foods. During the first series of treatments the patient did not seem to do well when the vaccine was rapidly increased, but when more slowly increased improvement was rapid.

Treatment with Bacterial Vaccines of Patients Who are Not Sensitive to Proteins.—CASE 4.—K., a woman aged thirty-six, has had asthma for the past four years and is free from it only a few days at a time. She has a constant cough, with much expectoration. Asthma is worse at night when she wheezes so much that she has to have a hypodermic of adrenalin chlorid and has to take aspirin. She requires several pillows at night and slight exertion causes her to wheeze. For a year she was treated with phylacogen vaccines without benefit. She is a little freer from asthma in Boston than in a city where she lives, 40 miles distant; she has spent considerable time in different parts of the South, West, and Southwest without any relief from asthma.

Skin tests were negative with all proteins.

From the patient's sputum was recovered a diphtheroid organism whch was the predominating one in the culture-media.

The patient was treated twelve times at five-day intervals with a stock Staphylococcus pyogenes aureus vaccine in gradually increasing amounts without relief. The patient was then given twelve treatments with the diphtheroid organism which was recovered from her sputum. These vaccines were given at weekly intervals and in gradually increasing amounts from 200,000,000 to 1,000,000,000. After the second treatment the patient became free from cough, dyspnea, and asthma; a week later she dispensed with the extra pillows and with adrenalin chlorid entirely, but she would wheeze a little unless she took 5 grains of aspirin at night. She was practically free from symptoms for nine weeks and treatment was discontinued. After this, treatment was given at irregular intervals for five months, during which time the patient remained practically free from symptoms.

Discussion.—This case illustrates the difficulty in finding a suitable locality where an asthmatic patient may live with freedom from asthma. It also illustrates the specificity in bacteria in the treatment of asthma caused by bacteria, since Staphylococcus pyogenes aureus vaccine was followed by no relief, whereas the predominating organism in her sputum—namely, a diphtheroid—was followed by comparative relief from symptoms.

CASE 5.—J. G., a housewife aged fifty-two, began to have asthma ten years ago at menopause, with a bad cold. Previous to the onset of asthma she had had bronchitis for years. She has asthma every night, requires several pillows, and has to burn an asthma powder several times each night. Asthma is worse in damp weather, winds, and after a hearty meal. She coughs all of the time and raises much sputum. Removal of polypi from nose relieved her of asthma for two months. Physical examination revealed a slight myocarditis, a slight trace of albumin and a few casts in the urine, and a systolic blood-pressure of 180 mm. Hg.

Skin tests were negative with proteins. From the patient's sputum was recovered a diphtheroid organism; this was the predominating organism in it.

The patient was treated nineteen times in the same number of weeks with a stock diphtheroid organism which was similar to the one recovered from her sputum. She immediately began to feel better and stronger and her cough and asthma gradually diminished until she was free from asthma after the fifth treatment, and she was free from cough and expectoration after the tenth treatment. She was now able to exercise without trouble. After treatment was discontinued the patient went two months with no asthma and no cough, and she did not have to burn her asthma powder. Four months later she was practically free from symptoms with the exception of some cough and a little choking up at night, so that she burned her powder once a night.

Discussion.—This case illustrates the type of asthma preceded by and associated with bronchitis and cardiorenal disease, although the latter evidently played no part in the cause of asthma, since following vaccine treatment the patient became practically free from asthma. The case also illustrates the frequent history of asthma aggravated by damp weather, winds, and overeating.

CASE 6.—S. C., a housewife aged thirty-seven, has had asthma for sixteen years; first attack followed typhoid fever. She rarely has any asthma in winter, but has bad asthma in summer, usually during June and July. Each attack lasts several

hours, and she has a series of these for two weeks, then she is free for a few weeks, when another series of attacks begin. Changes in the weather, colds, dampness, and exertion cause an attack of asthma. She has lived in England, Canada, and for the past few years in the United States, and she has had summer asthma as usual in all these places; she is, however, free from asthma near the salt water. The patient's paternal grandmother had asthma.

Skin tests were negative with all pollens and with bacterial proteins.

Treatment was begun the first of May with Staphylococcus pyogenes albus vaccine. This organism was chosen for treatment since at this time the patient had much secretion from the nose, and from this secretion a pure culture of Staphylococcus pyogenes albus was obtained. The vaccine was given at weekly intervals during May, June, and July; the amount of vaccine was gradually increased from 200,000,000 the first dose to 1,000,000,000 the last dose. Following the second treatment the patient had an attack of asthma on two days, but during the remainder of the treatment she was free from asthma and running of the nose. Treatment was discontinued, and during the fall the patient reported that she had continued to be free from all symptoms.

Discussion.—This case illustrates the summer type of asthma due to bacteria. She was not sensitive to pollens, and evidently pollens played no part in the cause of her asthma. Since this was the first summer in sixteen years that she was free from asthma during the summer months, it would seem that she had been benefited by Staphylococcus pyogenes albus vaccines; even changes in the weather, dampness, and exertion had failed to cause asthma. Although she had lived in a number of different places she had no freedom from asthma in any of them.

Results of Treatment.—Patients whose asthma is due to the proteins of horse dandruff and cat hair are relieved of asthma by subcutaneous injections of these proteins; the more thorough the treatment, the more permanent is the relief. Patients whose asthma is caused by pollens are usually kept from having asthma

the ensuing season provided a course of treatment is given with the pollen before the approach of the pollen season; such treatment does not ensure permanent relief and it is probably best to treat with pollens each year. Bronchial asthmatics who are sensitive to the proteins of Staphylococcus pyogenes aureus and albus are relieved of attacks during treatment with vaccines of these organisms, and such relief continues for from four to six months after treatment is discontinued; a second course of treatment relieves a relapse quicker than did the first course and relief is more permanent. Bronchial asthmatics who are sensitive to the food proteins are relieved of asthma while such foods are omitted from the diet; subcutaneous injections of the food proteins do not usually increase the tolerance of the patient for them.

Patients who are sensitive only to closely related proteins are the simplest to treat, and those who are sensitive to several types of proteins which are not closely related are the most difficult to treat. This is because at first one cannot judge which protein is the cause of asthma at the present time, and so several proteins may have to be tried before the correct one is used. This multiple sensitization does not detract from the value of the skin reaction, since each of the proteins to which the patient is sensitive may have at some time been the real cause of asthma.

Patients with bronchial asthma associate attacks with dampness, changeable weather, winds, menstruation, indigestion, nervousness, colds, and bronchitis. After treatment with proper proteins these patients become tolerant to such conditions and do not have asthma from such causes. There seems to be two types of colds and bronchitis: one type is anaphylactic, and relief or freedom from this type follows proper protein treatment; the other type seems to be due to bacteria and frequently vaccines prevent and relieve these.

The treatment of the non-sensitive group of asthmatics is no less simple than that of the sensitive group. About one case in six is relieved of asthma by vaccines made from a diphtheroid organism; this particular type of bacteria is chosen for treatment when it happens to be the predominating organism in the patient's

sputum. Frequently patients are relieved of asthma following treatment with vaccines of Staphylococcus pyogenes aureus and albus when these organisms happen to be present in the patient's sputum or nasal secretion in large numbers. Occasionally patients are relieved of asthma by vaccines made from a Gram-negative bacillus (so far not identified) when this organism is the predominating one in the sputum. In one case Friedländer's pneumobacillus was the predominating organism in the sputum, and in this case asthma was relieved by vaccines of this organism. Sicard has relieved several patients of asthma by streptococcus vaccines. Therefore the bacterial causes of asthma are very numerous, and for this reason this type of asthma is difficult to treat properly, since many different types of vaccines may have to be tried before the proper one is found. Since the non-sensitive patients usually have chronc bronchitis, this condition must be treated, and in such cases expectorants are helpful. Bacterial foci must be sought for and, if found, they must be eliminated. Cardiorenal disease also may cause asthma; in some instances, however, the nocturnal dyspnea associated with this disease is not asthma.

No matter what the cause of asthma may be, either in a sensitive or in a non-sensitive patient, adrenalin chlorid 1 : 1000 in subcutaneous doses of 15 minims or 1 c.c. is the most reliable for immediate relief in an acute attack of asthma; rarely is it necessary to give morphin or other such drugs.

CONTRIBUTION OF DR. GEORGE W. HOLMES

MASSACHUSETTS GENERAL HOSPITAL

THE EXAMINATION OF THE HEART AND GREAT VESSELS BY MEANS OF THE *x*-RAY

The Value of the *x*-Ray in Checking Up Studies in Percussion; Technic.

IN the *x*-ray we have a fairly satisfactory means for obtaining accurate information as to the size, shape, pulsations, and respiratory movements of the heart. None of this data can be obtained as accurately by any other method of physical examination. The size of the heart as demonstrated by percussion is not sufficiently accurate to be of scientific value. This statement is based on personal observation, and the opinion expressed by clinicians who have made careful studies of the value of the various methods used for obtaining the size of the heart. Percussion errors are due to the fact that the walls of the chest are not flat, and lines of vibrations at right angles to them are not at right angles to the borders of the heart. These errors increase as the chest wall becomes more rounded or the size of the heart increased.

The value of obtaining definite data as to the size of the heart is obvious. Perhaps its greatest help is in determining the value of treatment, and in differentiating between organic and inorganic murmurs. It is also valuable in checking up studies in percussion. In an examination of the heart and great vessels by means of the *x*-ray we should obtain the following data: Size, shape, pulsations of the various chambers. Its movements with respiration, changes which may take place with change in the position of the patient, and the size and shape of the aorta

both in the anteroposterior and lateral diameters. The relative position of the diaphragm also should be recorded.

This data may be obtained by the use of parallel rays (orthodiography) or by a combination of teleroentgenography and fluoroscopy examination. Teleroentgenography was introduced

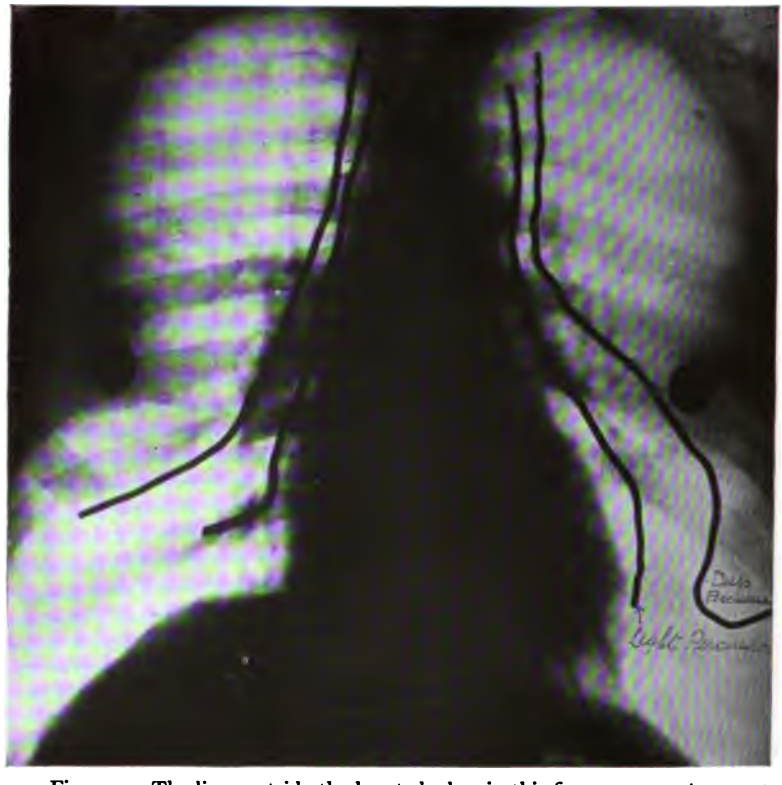


Fig. 192.—The lines outside the heart shadow in this figure represent an area of cardiac dulness as obtained by percussion. Lead markers were placed on the skin previous to the taking of the 6-foot plate. Note the difference in the size and shape of the heart as obtained by the two methods.

by Köhler. Its advantages as compared with orthodiography has been studied by Dietland, and the relative value of the two methods carefully considered. In general, teleroentgenography has the advantage of eliminating the personal equation and of producing a permanent record. Its disadvantages are the

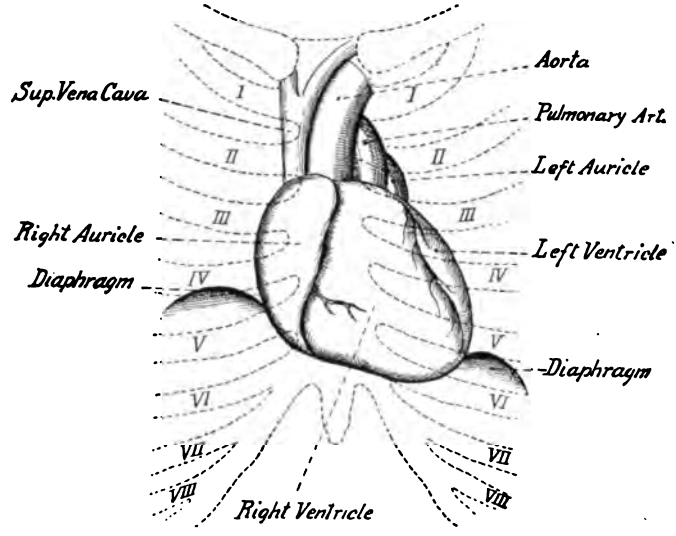


Fig. 193.—The anatomy of the heart in relation to the chest wall. (From Groedel.)

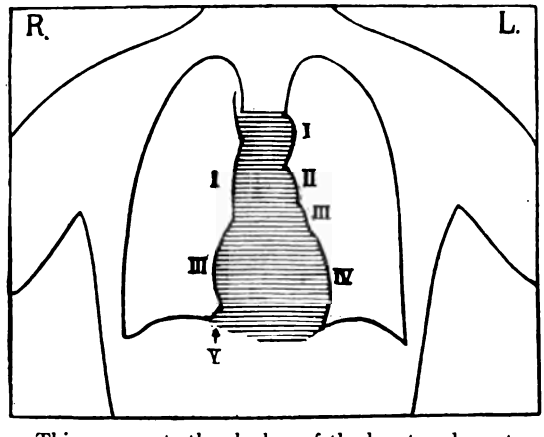


Fig. 194.—This represents the shadow of the heart and great vessels as seen in the anteroposterior view. On the left: I, Prominence of the aortic arch; II, pulmontory artery; III, left auricle; IV, left ventricle. On the right: I, Ascending aorta and great veins; III, right auricle. (From Groedel.)

slightly higher cost and the difficulty of demonstrating the apex of the heart and the junction of the left auricle and left ventricle, which points are of importance in making measurements. There

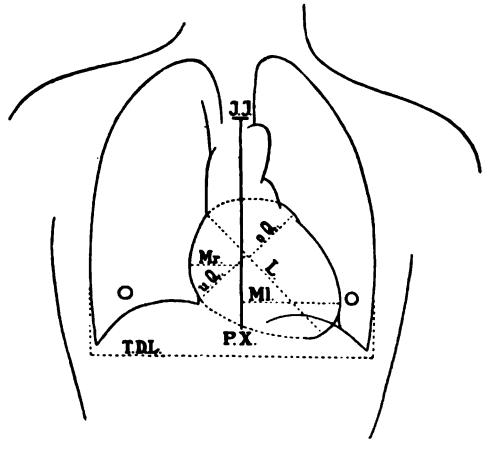


Fig. 195.—The points from which the measurements are obtained. (From Groedel.)

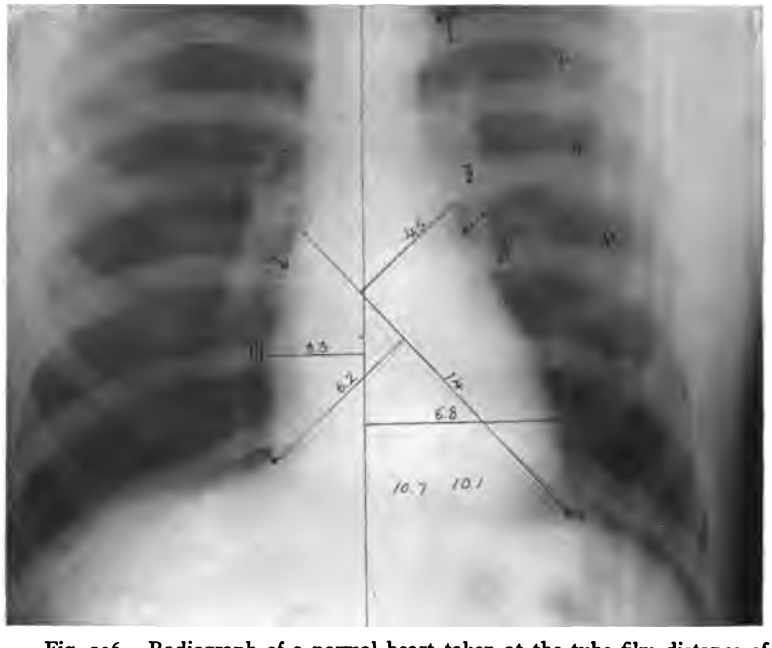


Fig. 196.—Radiograph of a normal heart taken at the tube film distance of 6 feet. The curves of the various portions of the heart and great vessels are indicated according to Fig. 194.

also may be considerable error if care is not taken to prevent rotation of the patient. The plates should be at right angles to the central ray from the tube, which should pass through the antero-posterior diameter of the chest at about the middle of the heart shadow.

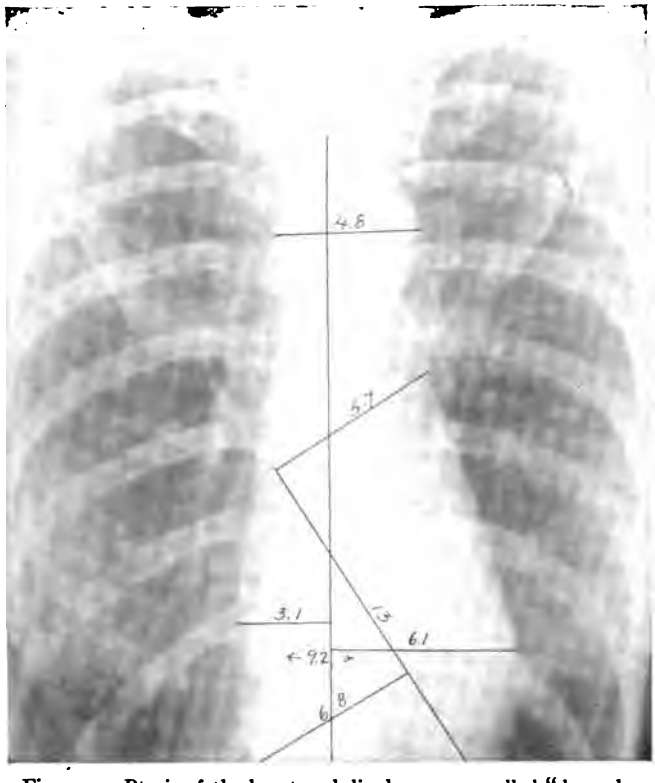


Fig. 197.—Ptosis of the heart and diaphragm; so-called "droop heart."

Orthodiography or the use of parallel rays has the advantage of being slightly more accurate when used by experts, considerably cheaper, and by it the junction between the left auricle and ventricle can be demonstrated. Also in a considerable percentage of cases the apex can be outlined. Its disadvantages are the amount of training required by the operator before his work becomes accurate and the fact that the

personal equation must enter to some extent into every case examined.

By fluoroscopy it is possible to obtain a fairly accurate outline of the shape and position of the heart shadow, its movements with respiration, and any change of shape which may occur with change of position. By combining this data with the data obtained from a plate taken at a distance of 6 feet, all the possible

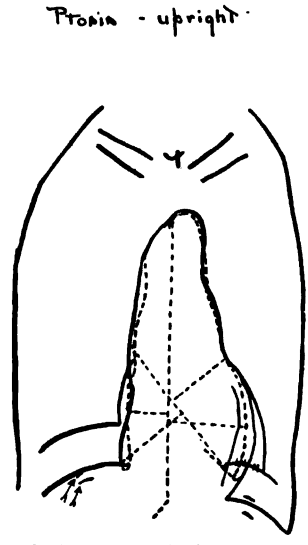


Fig. 198.—Tracing of the heart and diaphragm common in ptosis. The short lines indicated by arrows represent the excursion of the diaphragm during normal breathing. The long lines parallel to them represent the position of the diaphragm during forced inspiration and expiration. Notice that there is no downward excursion of the diaphragm during forced breathing, and that the upward movement in expiration is greater than normal.

data to be obtained from an *x*-ray examination of the heart is secured.

The following technic has been developed and used by us during the past five years, and has been found quite satisfactory: The examination is made preferably in the upright position. A fluoroscopic study is first made with the tube at a distance of 2½ feet. At this distance very good illumination of the chest can be obtained with a small amount of current. The respiratory

excursion of the diaphragm and the outline of the heart and great vessels are observed and tracings made on glass, which is later transferred to a chart (Fig. 210). Observations are made as to the rapidity, force, and time of the pulsations in the various chambers. The positions for obtaining the preceding data are the antero-posterior and right oblique. Where aneurysm is found or suspected, it may be necessary to use the left oblique and lateral

Fig. 199.—Aortic regurgitation with hypertrophy of the left ventricle. This plate was taken at a distance of 2 feet, with the patient in the upright position.

views, or examination in the prone position if fluid in the pericardium is suspected. After completing the fluoroscopic observations, and marking on the chest wall a point opposite the central portion of the heart shadow, the plate with the target of the tube at a distance of 6 feet is made. Intensifying screens are used. The exposure is long enough to include a full heart cycle, thereby obtaining the shadow of the heart in diastole.

The patient is not asked to take a deep breath or to hold the

breath. The amount of change in the size, shape, or position of the heart during normal breathing is very small, whereas the change in forced inspiration or expiration is considerable, and as it is not usually possible for patients to take the same depth of breath on different occasions, comparison of results would be impossible. It is particularly important that the central rays

Fig. 200.—Same patient as Fig. 199. The plate, however, was taken at a distance of 6 feet. Note that in Fig. 199 there is not only magnification of the heart shadow but also distortion of the shape. Figure 197 shows the typical appearance of the heart outline in aortic disease.

from the tube pass through the chest in a plane at right angles to the transverse diameter of the chest. If there is rotation of the patient the shadow of the heart will be changed both in size and shape. This can be avoided by care in placing the patient for the examination. The plate or screen should lie on the anterior chest wall. In stout people it is better to tilt the plate than to have the patient lean forward or to allow the upper portion of

the plate to be at a considerable distance form the chest wall, as this tends to distort the shadow of the upper part of the heart and great vessels. A tube of fairly high penetration should be used with a moderate amount of current. The length of the exposure may be from five to twenty seconds.

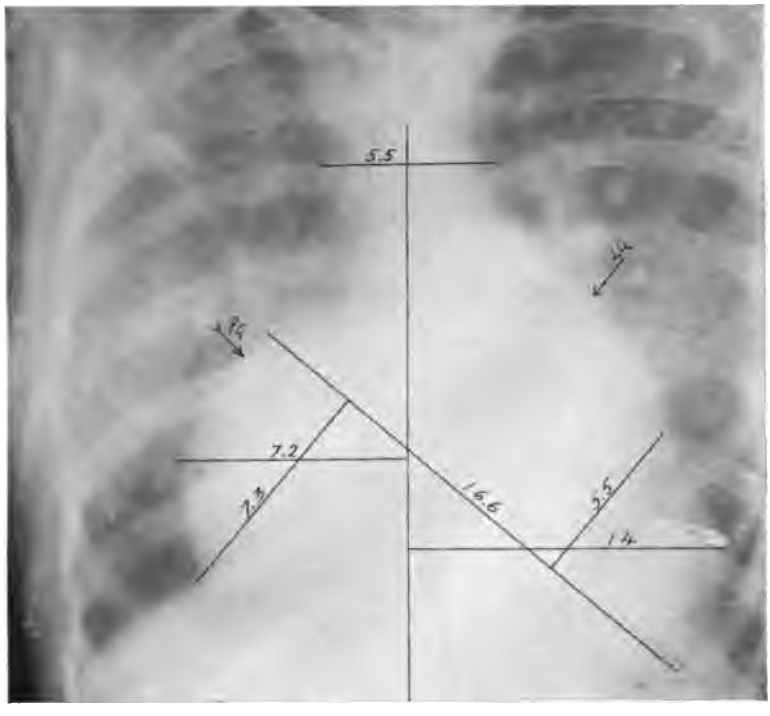


Fig. 201.—Mitral disease, regurgitation, and stenosis. Note the marked prominence of the heart shadow in the region of the right and left auricles. Compare its appearance with Figs. 196 and 200.

In order to interpret the findings it is necessary that the observer have a working knowledge of the x-ray anatomy of the chest. The shadow of the normal chest is composed of the thoracic wall, a central shadow composed of the superimposed sternum, heart, great vessels, mediastinum and spine, the diaphragm, and the lung fields. Normally the central shadow should approximate Fig. 196. At the top of the left side the edge of the arch

of the aorta appears with the descending aorta extending downward from it. Next comes the slight prominence of the pulmonary artery and the small prominence of the auricle, below which is the rounded mass of the left ventricle, making up the larger part of the shadow on this side and disappearing below the line of the diaphragm. On the right, above, the edge of the shadow

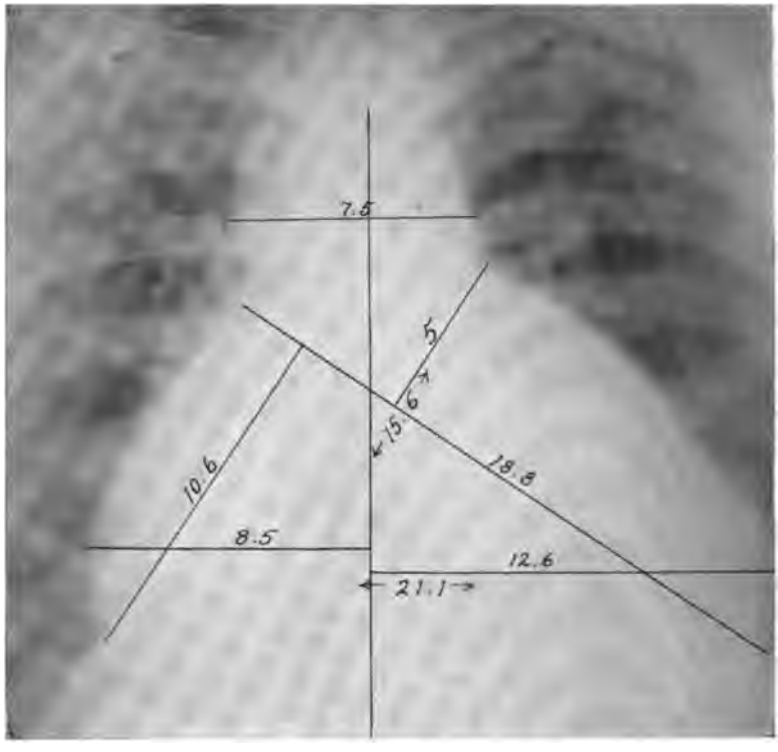


Fig. 202.—General enlargement of the heart shadow due to dilatation.

is formed by the ascending aorta and great veins, below is the curve of the right auricle which joins the right ventricle near the line of the diaphragm. The right ventricle is usually not seen, as it lies in front of the mass of the heart.

The shadow of the pericardium is not distinguishable from that of the heart unless it is calcified or contains air. Patho-

logic processes in the lungs or pleura may displace or distort the shadow of the heart and great vessels. The change in position of the diaphragm will also produce changes in the shadow of the heart. Diseases of the heart valves are accompanied by an enlargement of the shadow of the corresponding chamber or chambers. For instance, in mitral regurgitation we have en-

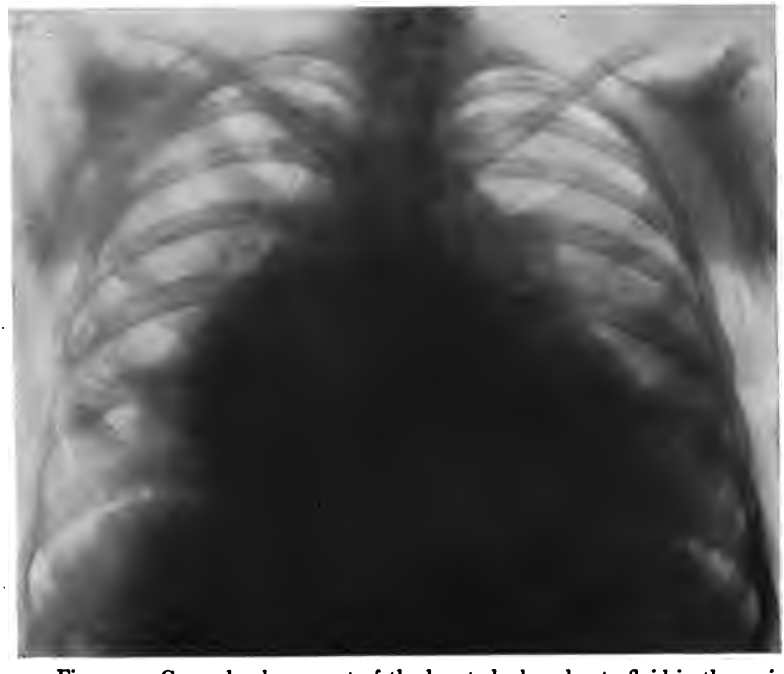


Fig. 203.—General enlargement of the heart shadow due to fluid in the pericardium, taken with the patient in the prone position, tube film distance 6 feet. Note that the shape of the shadow is roughly triangular and that the cardiohepatic angle is not obliterated. Compare with Figs. 202 and 204.

largement of the shadow of the right auricle and right ventricle. A knowledge of the physiology and pathology of the heart will enable one to interpret quite accurately these lesions from the changes in the shape of the heart shadow. Auricular fibrillation may be determined by the tremendous enlargement of the shadow of the auricles and the absence of visible pulsation. In heart-block if the pulsation is not too rapid it is possible to com-

pare the beats of the auricle with those of the ventricle and determine their respective rapidity. Dilatation is seen as a general enlargement of the heart shadow with weak pulsation and an absence of the rounding of the apex seen in the hypertrophied heart. Congenital abnormalities of the heart give rise to changes

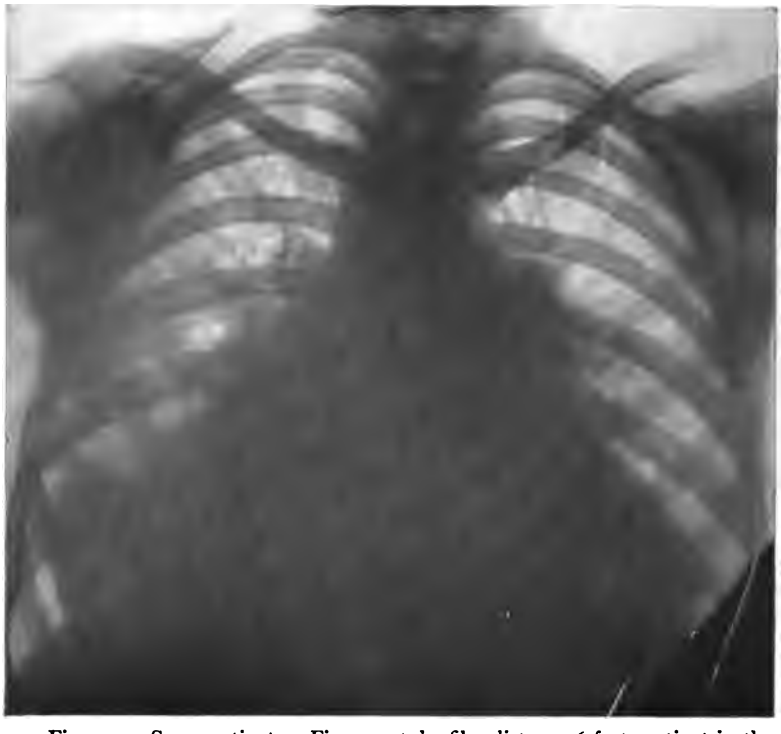


Fig. 204.—Same patient as Fig. 203, tube film distance 6 feet; patient in the upright position. Notice that the shadow has assumed roughly the appearance of a water-bottle. The lower part of the shadow has increased; the upper part diminished, due to the shifting of fluid in the pericardium. Compare with Fig. 203.

in shape and abnormal areas of pulsation. Here again the knowledge of the *x*-ray anatomy and the pathology of the heart and great vessels will enable one to arrive at a diagnosis.

Fluid in the pericardium tends to give a triangular shaped shadow. When prone there is an increase in breath of the upper portion or apex of the triangle. When upright it may assume a

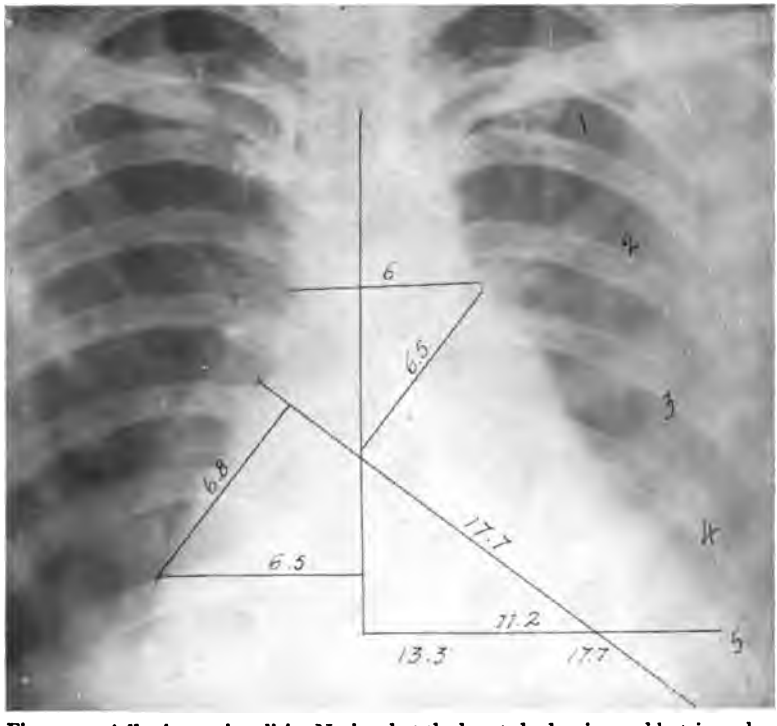


Fig. 205.—Adhesive pericarditis. Notice that the heart shadow is roughly triangular and that its outlines in the lower portion are rather indistinct.

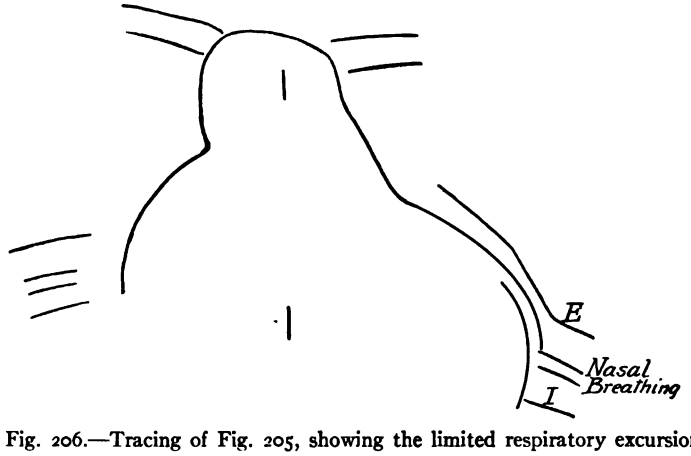


Fig. 206.—Tracing of Fig. 205, showing the limited respiratory excursion of the heart. The lines marked with the arrows represent the positions of the left border during forced breathing.

water-bottle appearance. The cardiohepatic angle is not necessarily obliterated, although it may be so to percussion. Pulsation is considerably diminished or absent. In obtaining the shape of the heart in the different positions for comparison it is not wise to depend on screen observations alone; either a careful tracing or plate taken at a distance of 6 feet should be made, and the outlines thus obtained superimposed.

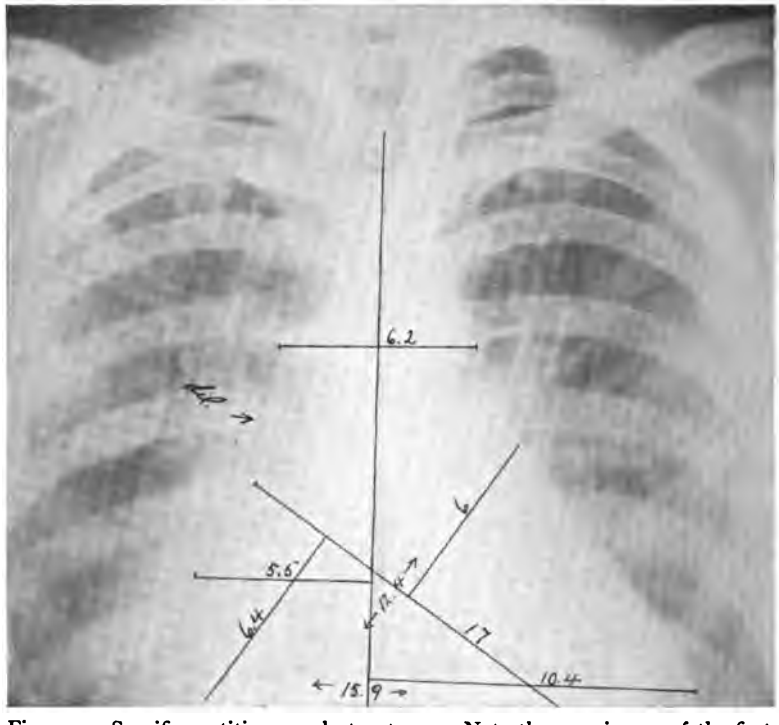


Fig. 207.—Specific aortitis proved at autopsy. Note the prominence of the first portion of the aorta as indicated by the arrow.

Adhesive pericarditis may prevent to a certain extent the respiratory movements of the heart. Figures 205 and 206 illustrate such a case which was proved at autopsy. The shape of the heart shadow is not necessarily changed in this disease, but its outline is usually less distinct, as are also the pulsations. Changes in the shadow of the great vessels may be due to dilata-

tion, arteriosclerosis, or aneurysm. Dilatation of the aorta may be of the ascending, transverse, or descending portion, or it may be diffuse. It has been shown that in a considerable percentage of cases of specific aortitis the lesion occurs near the aortic valve, and that this portion of the aorta is the first to become weakened. Therefore in this type of case we should expect to see a bulging

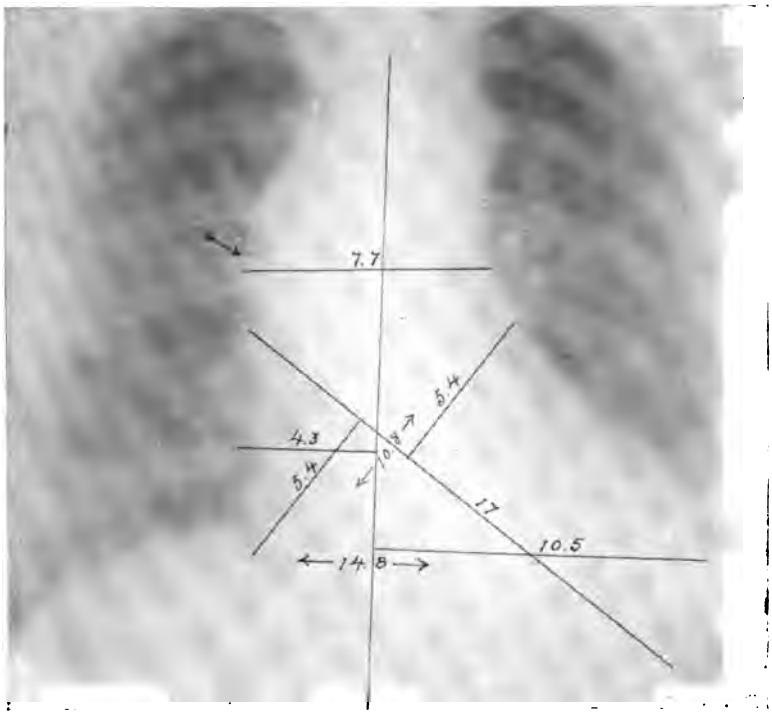


Fig. 208.—Specific aortitis with marked prominence of the first portion of the aorta; possibly beginning aneurysm.

of the shadow of the ascending aorta on the right side just above the right auricle. A case proved at autopsy is illustrated in Fig. 208. Where the process is more general, the findings are shown as an increase in the transverse diameter of the shadow of the great vessels. Differentiation between a marked dilatation and a small aneurysm is not always possible. Usually, however, the aneurysm appears as a dense, sharply defined mass pro-

jecting from the shadow of the great vessels. Pulsation may or may not be visible. Its position, right, left, or central, will depend upon whether or not it rises from the ascending, descending, or transverse portion of the arch.

Arteriosclerosis is shown by a wider curve to the arch, noticeable as a prominence high on the left. It is not usually possible to demonstrate the presence of calcification in the aorta.

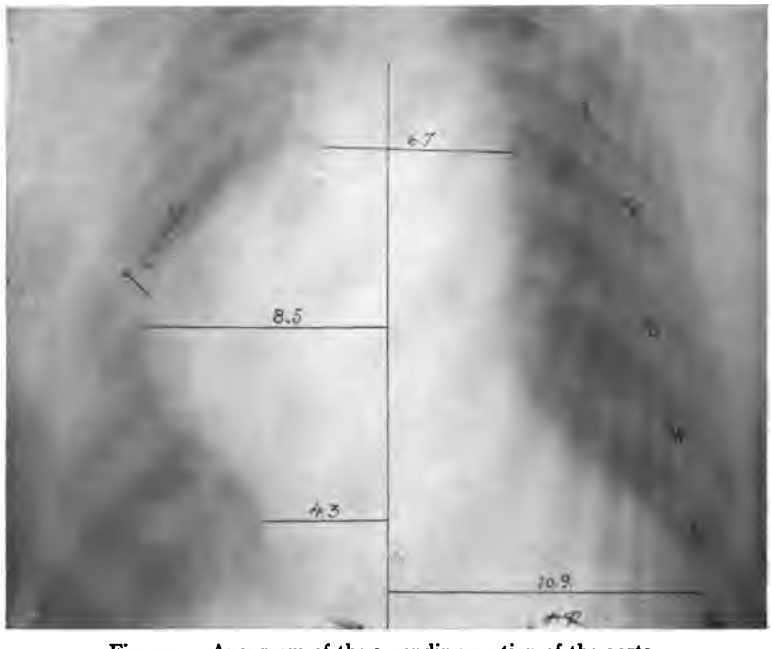


Fig. 209.—Aneurysm of the ascending portion of the aorta.

The methods of examination used in this clinic, while not entirely free from errors, are sufficiently accurate for all practical purposes. In conclusion I wish to emphasize the necessity of the 6-foot target film distance for obtaining the plates from which the measurements are taken, and of making the exposure during normal breathing. Accurate measurements cannot be obtained from plates made with shorter tube distance, because the amount of magnification of the heart shadow due to divergent rays depends not only upon the distance of the source of the rays from

it but also upon the distance of the heart from the plate and upon its size. It is therefore essential that parallel or nearly parallel

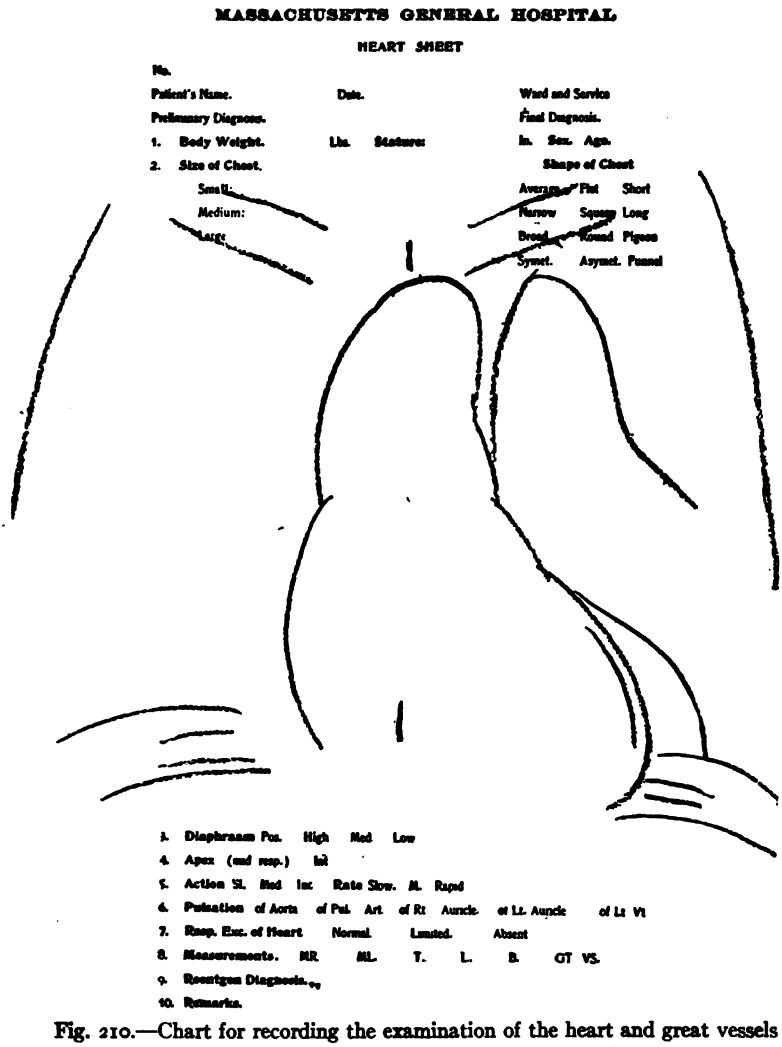


Fig. 210.—Chart for recording the examination of the heart and great vessels in use at the Massachussets General Hospital. The tracing on it is that of a normal heart. Notice the amount of respiratory excursion of the left side of the heart.

rays be used. Appended is a table (p. 1214) giving the average normal measurements of the adult heart.

CLAYTOR, MERRILL: ORTHODIAGRAPHY

TABLE 1.—Vertical Heart Measurements. Male (37 cases).

Weight, pounds.	Cases.	Mr.	Ml.	T. D.	L. D.	
		3	7.0	10.7	11.8	Min.
120–129	3	3.7	7.2	10.9	12.6	Av.
		4.3	7.5	11.3	13.5	Max.
		3.5	7.5	11.0	12.0	Min.
130–139	5	3.8	8.0	11.8	13.2	Av.
		4.2	8.5	12.5	14.0	Max.
		3.4	7.0	11.0	12.0	Min.
140–149	9	4.0	7.7	11.9	13.4	Av.
		4.6	8.4	13.1	14.5	Max.
		3.2	7.8	11.5	12.5	Min.
150–159	8	3.9	8.4	12.3	13.5	Av.
		4.5	9.0	13.0	15.0	Max.
		3.7	8.0	12.0	14.0	Min.
160–179	6	4.0	8.2	12.4	14.6	Av.
		4.8	9.0	13.8	15.8	Max.
180–200	6	3.8	7.0	11.0	14.0	Min.
		4.2	8.7	12.9	14.7	Av.
		4.5	9.7	13.4	15.3	Max.

TABLE 2.—Vertical Heart Measurements. Female (54 cases).

Weight, pounds.	Cases.	Mr.	Ml.	T. D.	L. D.	
100–109	2	3.2	6.7	9.9	12.0	Min.
		3.3	6.8	10.2	12.1	Av.
		3.5	7.0	10.5	12.3	Max.
110–119	3	3.0	7.0	10.0	11.5	Min.
		3.1	7.6	10.7	11.9	Av.
		3.2	8.0	11.1	12.4	Max.
120–129	14	2.3	6.4	10.2	10.5	Min.
		3.5	7.5	11.0	12.2	Av.
		4.2	8.6	12.2	13.8	Max.
130–139	19	3.0	6.4	9.6	11.2	Min.
		3.4	7.8	11.2	12.4	Av.
		4.0	8.8	12.6	13.3	Max.
140–149	5	2.6	7.0	10.0	12.2	Min.
		3.5	7.6	11.1	12.7	Av.
		4.1	8.3	11.8	13.2	Max.
150–159	7	3.1	7.6	10.9	12.3	Min.
		3.6	8.0	11.6	12.9	Av.
		4.8	9.3	12.8	14.2	Max.
160–175	4	3.5	6.5	10.6	11.8	Min.
		3.8	7.9	11.7	12.6	Av.
		3.8	8.5	12.3	13.0	Mean.
		4.1	9.0	12.8	13.2	Max.

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